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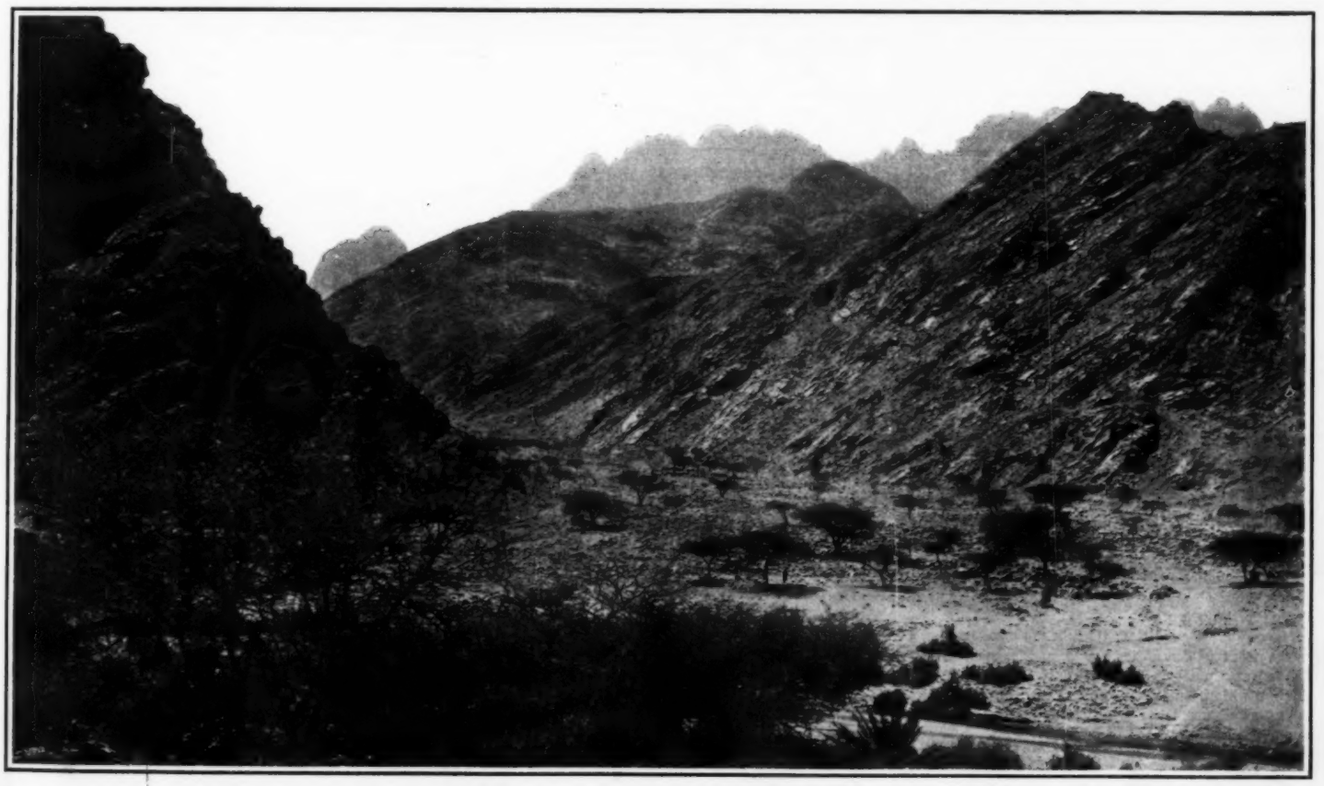
A TYPICAL VIEW OF THE BARREN AND AWE-INSPIRING MOUNTAINS OF SINAI. TAKEN LOOKING NORTHEAST FROM THE SUMMIT OF JEBEL MUSA



SCENE IN THE LOWER PART OF WADI FIRAN, THE PLACE WHERE THE ISRAELITES FOUGHT THE AMALEKITES. JEBEL SERBAL IS SEEN IN THE DISTANCE

THE "HOLY MOUNTAIN."—[SEE PAGE 40]

The Development of Submarine Boats—II*

From Bushnell to Holland and Lake

By Simon Lake

Concluded from Supplement No. 1828, page 26

THE author is free to admit that there are certain mysteries connected with the control of submarine vessels in a vertical plane that are not easily explained. While the problem of perfect control of such vessels in a vertical plane by the use of hydroplanes was solved on the first submerged trials of the "Protector," held early in 1903, at which time it was discovered that the "Protector" would maintain her depth automatically for considerable periods of time, the importance of the exact location of the hydroplanes was not at that time fully recognized nor appreciated until the trial of the "Lake" in 1907, which vessel was largely a duplicate of the "Protector;" but owing to certain overweight that crept in—primarily owing to the fact that the location of the hydroplanes had been changed from that of the relative position of the hydroplanes in the "Protector"—she would not submerge nor run on a level keel, and it required constant manipulation of the horizontal rudder to keep her submerged. When the overweight was removed and the position of the hydroplanes changed, she performed satisfactorily as a level-keel boat.

For the purpose of observing the stream lines passing over a boat while in the submerged condition, the author constructed an experimental tank in Berlin a few years ago and built models of various forms for the purpose of watching the action of the models when submerged, as it was impossible to observe the stream lines if the model was pulled. The tank was so constructed that the water could be driven by the model at a constant velocity by the use of propellers; the velocity of the stream could be increased or diminished as desired.

A model of the "Protector" submerged, was tried out in this tank. The model was free to move up or down a transverse shaft running through the model at a point half-way between the centers of buoyancy and gravity; wheels were fixed to the outer ends of this shaft. These wheels ran up and down on vertical wires on either side of the model. On the reserve buoyancy being reduced in the model to about that used in the full-size boat, the hydroplanes would cause the boat to submerge or emerge on a level keel, in the same manner as the full-sized ship. It was found that with a certain inclination of hydroplane the vessel would submerge to a certain depth and automatically maintain that depth as long as the velocity of the stream was fairly uniform. To go deeper required a greater angle of hydroplane or horizontal rudder. Just why a vessel will submerge only to a given depth with a certain angle of hydroplane is not altogether clear. At the time these tank experiments were made this fact did not impress itself on the author's mind as much as it has since, due to some recent trials with one of our foreign boats, which was submerged with a reserve buoyancy of about 600 pounds. When first submerged, it was running with an inclination down by the bow of about 1 degree. The boat ran for thirty minutes, maintaining a constant depth of between 31 and 32 feet, without touching either the horizontal rudder or the hydroplanes. It was then noticed that the boat had changed her trim for 1 degree down by the bow to 1 degree down by the stern, which was gradually increasing. Still the boat maintained her uniform depth. A movement of 1 degree of the horizontal rudder brought her to a level keel. When she showed a tendency to submerge further, 2 degrees less inclination to the hydroplanes brought her back to her original depth with head of periscope about 1 foot above the surface, and she ran thirty minutes more without touching anything, at which time she had again taken on an inclination of about 1½ degrees down by the stern. The boat was stopped, and it was found that she had lost all of her reserve buoyancy except about 10 pounds, and that a leaky valve had let about 600 pounds of water into the exhaust tank at the extreme after end of the boat. At rest she took an inclination of 5 degrees down by the stern.

Here was a condition that had never been previously noted in the author's experience, where the vessel ran at a uniform depth without touching anything, during which time she changed her reserve of buoyancy and changed her trim and yet maintained a constant depth.

This same phenomenon was later observed in another Lake boat, where, by moving men from one end of the boat to the other, the trim would be changed from down by the head to down by the stern, but the depth would remain constant, without changing inclination of horizontal rudder or hydroplane.

With a certain reserve of buoyancy and a certain inclination of hydroplane, therefore, the vessel will always go to a corresponding depth and run constant at that depth until conditions are changed; indeed, the author has heard the commander of one of these boats state, for the information of the members of a trial board, after first noting the vessel's reserve of buoyancy: "I will now set the hydroplanes at 10 degrees down and the horizontal rudder 2 degrees up, and the boat will submerge to a depth of 30 feet and run constant at that depth;" which the vessel did without his touching anything after she started to submerge.

The testing tank also showed up another curious thing. A model of one of the early United States boats of the "Adder" type, with the cigar form of hull, and with quite a considerable surface buoyancy, would automatically dive by the head at an angle of about 30 degrees, when the bow would lightly touch the bottom of the tank, and then she would reverse her inclination and come to the surface at about the same angle at which she dived. At times she would reverse without touching the bottom. This model had a metacentric height corresponding to about 10 inches in a full-sized ship. It was very interesting to observe this porpoise-like motion, which kept up continuously, as long as the stream was flowing, and it was impossible to set the horizontal rudder in any position to overcome this tendency. The porpoising motion was so rapid that it was impossible to get any accurate observation of the stream lines, but it is believed that the explanation is much the same as of the hydroplane action, viz., as the vessel gathers headway, the water piles up over the cigar-shaped bow, which, combined with the increased frictional resistance due to the streams passing under the hull, causes the bow to submerge, and the vessel plunges toward the bottom. A cross-section parallel to the surface, through the hull near the bow as she is diving, would show (if she was moving forward at the same time) that there would be a tendency to create a vacuum under the forward portion of the vessel, which would tend to increase the inclination, and she would continue to dive until a sufficient inclination and depth was reached whereby the greater head of water at the bow reduced the vacuum and consequent down pull on the bow, and at the same time the vacuum formed under the stern was proportionately increased, which, combined with the righting effect of the pendulum arm (her metacentric height) caused the forces to be reversed, and she would broach to the surface. The motion of the model would apparently synchronize, and the plunge toward the bottom and return to the surface again would occur with the regularity of clockwork. The obvious remedy for this tendency in a boat of the cigar-shaped form is to increase the metacentric height and the size of the control rudders and to keep in constant touch with the horizontal rudder.

The above theory may explain the fatal dives to the bottom of some of the vessels of the diving type.

One of the advantages of bottom wheels in surmounting obstructions, is in running in waters not well charted, where it is assumed that there are several fathoms of water, the keel striking and surmounting obstructions of unknown objects. The cushioning wheels take up the shock, and the vessel surmounts the obstruction without the hull coming in contact with the object.

Speed, as every engineer knows, is simply a question of lines and horse-power. The author has always felt that safety and ease of control should be the first consideration in the design of submarines. The submarine does not require great speed, especially under water. The submarine is the guerilla in warfare, and it is her province to lie in wait for her fleeter foe, the armored cruiser or the battleship. For preventing a close blockade of a port a very slow submarine would have frequent opportunity to intercept a blockading squadron. Speed is now becoming more desirable, however, as the submarine is going to take the offensive in naval warfare rather than the purely defensive position to which these vessels have been considered adaptable.

In the author's opinion the proper method of making a submarine attack is for the submarine to run on a level keel, a sufficient distance below the surface so that when the omniscope and periscope are withdrawn there is absolutely nothing on the surface to betray the fact that a submarine is in the vicinity.

The vessel which carries six of the deadly Whitehead torpedoes, all of which may be almost simultaneously fired: two at the bow, two at the stern, and two to either broadside. The periscope is kept housed except at the moment of taking an observation. Range-finding and direction-indicating devices are provided by means of which the navigator of the submarine may be constantly advised as to the position of the enemy. Observations may be made by suddenly shooting the head of the periscope just slightly above the surface and as rapidly withdrawing it. An observation may be taken and the distance of a known ship calculated in a space of time not exceeding two or three seconds, during which period no gun could be trained on so small an object as the head of a periscope, even if it was observed, which in a choppy sea is hardly likely, even at a distance of only 300 or 400 yards; and at a distance of a couple of thousand yards would be invisible even with a very powerful glass, provided the vessel did not have sufficient speed and the periscope did not remain above the surface long enough to create a wake. It is the wake of the periscope which attracts attention to a vessel running with the periscope above the surface all the time.

DISCUSSION.

In reply to questions by members, Mr. Lake stated as follows:

All of the French boats, so far, have been built in France, and all of the recent French designs have been made by French officers. He thinks that Goubet, the designer of a little French boat shown, experimented privately. The United States Government has furnished no designs. Its latest call for tenders distinctly states that the Government has no designs.

Reference was made to what is known as the Board on Construction, which has been discontinued. There is now a General Board, of which Admiral Dewey is the head. The Board on Construction was composed of the heads of the Bureau of Construction, the Chief of the Ordnance Bureau, the Bureau of Engineering, the Bureau of Equipment, and the Chief Intelligence Officer. These men would get together and decide on all classes of ships, except submarines, which class was formerly decided upon only by Congress. The Naval Board formerly had nothing to do with this, due to the wording of the legislation. Now, however, it does, and the Department issues circulars to shipbuilders and specifies what it wants in the way of armament and performance. Since the United States has the advantage of getting competitive bids, the requirements are as severe as, if not more so, than those of any foreign government.

The difference between a horizontal rudder and a hydroplane is this: A horizontal rudder is placed at the bow of the boat or at the stern and has simply a guiding function, to direct the course of the vessel up or down. The hydroplanes pull the boat up or down bodily, as it were. In the "Lake" type of boat they have always been equally distributed, one an equal distance forward and another an equal distance aft of the center of gravity, so that the forces acting upon them tend to force the boat down bodily on a level keel, and they also lift the boat on a level keel. With a horizontal rudder, one must change the whole angle of the boat itself, while with the hydroplanes one instantly gets down pull or up pull.

Air is compressed in steel bottles. Under the present government requirements, all submarines must provide for a certain number of cubic feet of air up to as much as 2,500 pounds per square inch. The United States Government made a number of trials in 1907 in which the "Fulton" and the "Lake" both remained submerged for a period of twenty-four hours. Mr. Lake had previously made experiments in 1897 to determine how long a crew could remain submerged living on air in the boat alone without drawing in an outside supply. The "Argonaut" was only 36 feet long, and was for a period of five hours submerged without drawing on any air-supply from outside. Eight men at Newport in the "Lake" remained for twenty hours under water without drawing on outside air, at the expiration of which time the air was getting a little thick, and Mr. Lake noticed that some of the men were losing interest in things about them. He had been observing the condition of the air by watching a lighted candle, measuring the height of the flame of the candle both at the top and at the bottom of the boat. In this way he could judge if carbonic acid gas was forming. He would repeat this test every hour, and after they had been submerged fifteen or sixteen hours he noticed that the flame began to diminish, which was the first indication of bad air. At the end of twenty hours it was impossible to keep the candle

* Proceedings of the Engineers' Club of Philadelphia.

lighted. About that time the men began to get sleepy and to breathe rather heavily; some fresh air was then admitted from the storage bottles. The pumps were started and pumped the foul air out from the bottom of the compartment and the fresh air was admitted at the top; the candle flame then immediately brightened. They then remained for two hours longer, until the candle flame began to show signs of getting weak again, when they repeated the pumping operation and remained for another two hours, and so on. When they came to the surface, they immediately got under way and went back to Newport, and none of the men suffered any bad effects.

Boats have electric heaters and cooking is done with electric apparatus; the crew lives aboard some of the boats altogether.

The French Government has been the most industrious in trying to use heavy oils for fuel for engines; in fact, abroad a number of Continental firms have been experimenting with the Diesel engine and have met with considerable success within the last few years. One government has proposed changing its gasoline engines for heavy oil engines, so well was it satisfied with their performance. Alcohol has not the same power as gasoline. When one attempts to provide a fuel which reduces power and speed, governments do not want it, so it looks as if the heavy oil engine is the solution of the problem. Heavy oil engines are now so successful that Mr. Lake proposes putting them in his future boats, but he has never felt warranted in doing so heretofore.

Compressed air is not carried in submarines for the sole purpose of providing air for the crew, but for the purpose of handling water ballast, discharging torpedoes, and working certain machines. The Whitehead torpedo is discharged by compressed air.

All of our boats are provided with a buoy which may be released to the surface. The Russian buoy has information printed upon it in three languages, English, Swedish, and Russian, notifying the finders that there is a submarine boat below and asking them to open the buoy. When one does so, a telephone is found inside by means of which one can talk to the boat below. There is a whistle on these buoys, which is blown by compressed air, and a light can be turned on at night; they also have a tube by which the boat can be supplied with fresh air.

Mr. Lake knows of no practical method for vessels to protect themselves against submarines that has been proposed. The putting out of booms, he considers, would be no defence at all, because it would reduce the speed of the surface vessel using it. The only protection vessels have to-day against submarines is to get into a landlocked harbor and then have the harbor closed after them. The putting out of booms and heavy chain netting would not assist them because their speed would be reduced so that the submarine could approach them at will and go under the chain if necessary, or fire a succession of torpedoes and destroy the booms. The only safety for the pursued vessel is to put out to sea and get away if she knows a submarine is below. The torpedo will put any ship out of business, and a submarine can approach any ship to-day. The next war will without doubt prove that these little "Davids" are invincible.

The British Government has made experiments exploding gun-cotton and found that an explosion 20 feet away from the vessel would do her no serious injury, but an amount of gun-cotton exploded directly beneath a ship, even at 100 feet depth, would. Mr. Lake believes that a submarine would not be injured unless a mine were exploded right under her; at a distance of 50 feet, it would not even rupture the hull.

The best speed for submarines, as far as Mr. Lake knows, is between 15 and 16 knots on the surface with gasoline engines. He thinks that will be increased considerably within the next few years.

Submarines are now built which have a submerged speed of 11 knots, and this will also probably be increased.

Mr. Lake has made experiments and has kept the hair-lines of the omniscope (which, by means of direction-indicating devices, aims the torpedo) pointed right on the stem of a vessel for a period of as much as five minutes at a time; that was actually done while a vessel was passing at a good rate of speed. The man at the observing instrument can check on his hair-lines and certain measuring devices the course of the vessel and correct the same. The difficulty is, will the torpedo run straight? Torpedoes are now made that will run up to 4,000 yards.

Mr. Leavitt, who is the inventor of the torpedo of that name, suggests that it might pay with torpedoes used by submarines to increase the charge of gun-cotton and reduce the run. Mr. Leavitt sees no necessity for torpedoes which run over a thousand yards to be fired from submarines. Of course, when one fires at 4,000 yards, the chances for making a hit are much decreased.

Vanadium—Its Discovery and History

Found in a Brown Lead Ore from Zimapan, Mexico

IN a formal communication dated at the city of Mexico on the second of the month Messidor in the ninth year of the French Republic, Humboldt and Bompland first announced the discovery of the metallic element vanadium to the National Institute of France.

The date given corresponds to the 21st day of June, 1802, but the notice of the discovery was not published until 1804, when it was inserted in the Annals of the National Museum of Natural History.

The discoverer of the new element was Manuel Del Rio, Professor of Mineralogy in the city of Mexico. He found it in a brown lead ore from Zimapan, and after noting that it was different from chromium and uranium, called it erithronium because of the red color of its salts.

In May, 1803, or before Humboldt's letter to the French Institute was published, there is an obvious reference to vanadium under the name of panchrome, the article appearing in Spanish in the "Annals de Ciencias Naturales," and Del Rio being credited with the discovery of the substance.

Humboldt, together with his letter concerning erithronium, sent to France samples of the brown mineral in which it had been found. Collet-Descostils, an engineer in the Corps of Mines, already known for his work on platinum and his reputed discovery of rhodium, was entrusted with the analysis of the Mexican ores. His report was negative in reference to erithronium and concludes with the statement that the tests which he had made seemed sufficient to prove that these ores did not contain any new metal.

Before he learned of the results of Collet-Descostils's analyses, and even before the announcement of his discovery had reached France, Del Rio changed his opinion and regarded erithronium (or panchrome) simply as a basic chromate of lead. Writing on the lead minerals from the district of Zimapan he states:

"From this brown lead ore, I have extracted 14.80 per cent of a metal which at first seemed a new one, and which I called panchrome because of the different colors presented by its oxides, its solutions and its precipitates; then I named it erithronium because it formed with alkalies and earths certain salts which became red under the action of heat and acids. But having read in Fourcroy that chromic acid also furnishes red and yellow salts by evaporation, I concluded that the brown lead ores were chromates of lead with an excess of base in the state of a yellow oxide. Until the present, it has been regarded as a phosphate of lead."

Del Rio thinking that he had made a deeper study of the minerals, thus concluded that he had made an error in his first report, and he gives the result of his subsequent analysis of the lead ores as follows:

"The brown lead mine contains 80.72 per cent yellow oxide of lead, and 14.80 per cent of chromic acid; the remaining 4.48 per cent consists of arsenic, iron oxide and hydrochloric acid."

Panchrome and erithronium, renounced by their discoverer and passed undetected by an eminent French chemist, were then forgotten and never entered the list of the chemical elements.

More than a quarter of a century later, in November, 1830, Berzelius writes the following letter to Dulong:

"M. Sefström, director of the School of Mines of Fahlun, on examining a piece of iron remarkable for its extreme softness, has just recognized in it the presence of a substance of which the properties differ from those of all the elements known up to this time; but the proportions of this substance are so small that it will require much time and expense to obtain a quantity sufficient for a thorough examination. The iron comes from the mines of Taberg in Smaland, the ores of which also contain traces of the new substance. M. Sefström having discovered that the pig iron contained a larger proportion of the substance than the iron refined therefrom, concluded that the slags formed during the conversion of the pig iron into refined iron would be still more rich; this conjecture was soon confirmed and M. Sefström, having thus succeeded in procuring a sufficient quantity of the new substance to enable him to study it, came to me during the holiday vacation to finish his researches on the subject."

Sefström, after many experiments on the Taberg irons, applied himself to studying the characteristic reactions of the new element, and to marking the distinctions between it and chromium and uranium, both of which metals exhibited many analogies. The result was that with only two decigrammes of material to work upon, he established the existence of the new element beyond question. He recognized its several degrees of oxidation and even described some of its salts.

Taking up his researches again in the autumn of 1830, at Fahlun, in the laboratory of Berzelius, he succeeded in extracting further quantities of the new element from furnace slags, indicated his method of recovering it, and named it vanadium, from Freya Vanadis, the principal goddess of Scandinavian mythology.

Hidden in the earth since time began, suspected for thirty years and then conclusively recognized, vanadium thus took its place among the elements in the year 1830.

Berzelius, in his communication to the "Annales de Chimie et de Physique," credits Sefström with the discovery of vanadium, gives the result of his researches and commends him for his success in overcoming unusual difficulties.

Berzelius then endeavored to isolate the metal, but failed. Attempting to reduce the oxides by carbon and by hydrogen he obtained in both cases only a lower oxide with a somewhat metallic luster. Using potassium, he obtained a grayish powder which gave a metallic luster when polished. He then heated vanadium chloride in a current of dry ammonium gas and produced a compound with a brilliant metallic luster but which Schafarick proved was only the nitride of vanadium.

Johnson, Crudnowicz, Rammelsberg and Schabus continued the work on vanadium and without isolating it, succeeded in fixing its classification in the system of elements.

Sefström had found vanadium in iron ores other than those of Taberg; Kersten found it in 1841 in the copper-schists of Mansfield and Thuringia; Woehler discovered it in the pitchblend of Joachimsthal, now so famous on account of its radio-active elements. But in none of these cases did the vanadium content run higher than one-tenth of one per cent, and the combinations made by the metal remained undetermined. No industrial application had been found for it, and its detection in widely scattered localities was simply a matter of chance.

In 1859, H. St. Claire Deville sent a note to the Academy of Sciences and indicated the presence of considerable quantities of vanadium in a ferruginous-aluminium deposit at Baux, between Arles and Toulon.

About this time vanadium was discovered in many kinds of clay throughout France; Terreil found it in some Sevres pottery, but in very small quantities.

St. Claire Deville suggested the first industrial application of vanadium as a coloring agent in ceramics. He also prophesied its larger employment in metallurgy after noting the improvement in some cast iron that showed the presence of vanadium.

Commercial caustic soda and potash usually contain vanadium; sulfide of sodium, even the purest kind, always presents a slight yellowish tinge, due perhaps to traces of vanadium. Roscoe found it in 1867 in the copper deposits of Cheshire, England. Witz and Osmond found it in the basic slags from the Creusot furnaces, in which the oolithic ores of Mazenay were used, the quantity rising as high as one per cent. This vanadium was used exclusively in the manufacture of aniline black because of its powerful oxidizing properties.

Vanadium exists in considerable quantities in the oils and anthracites of South America, and is found in the titaniferous iron ores of the Adirondacks. It has been found in meteors and exists in some stars and the sun.

Sir Henry Roscoe isolated it in the metallic form in 1867. Moissan made cast vanadium in the electric furnace in 1894. Helouis developed a commercial process for the preparation of vanadic acid in 1896, and produced in the same year alloys of vanadium and iron by the alumino-thermic process.

Electric traction matters are very active in the Pyrenees region of France. About 200 miles of standard gage road will be equipped by the South Railroad Company from Bayonne to Toulouse. The work will be started with the 65-mile section between Montrejeau and Pau. For this thirty motor cars have already been ordered, and they will take 100-ton passenger trains. On this line the single-phase 300-volt system will be used. The company is taking steps to erect these hydraulic plants in the mountain region to secure the current.

Experimental Science Teaching

Some Applications of Mariotte's Bottle

THE apparatus known as Mariotte's bottle consists, in its simplest form, of a half-gallon or gallon bottle (*A* in Fig. 2) having a horizontal outlet tube near its bottom, and a vertical tube, which passes through a cork into the neck and extends inside the bottle, to any desired level higher than the lateral outlet. When the bottle is filled with water and the outlet is opened air enters in bubbles through the vertical tube and water flows from the outlet in a stream of constant velocity as long as the level of the water in the bottle is higher than the bottom of the vertical tube, because in these conditions the effective "head" of water that determines the flow is the height of the bottom of the air tube above the outlet, no matter what the actual level of the surface of the water in the bottle may be. Mariotte's bottle, therefore, affords a convenient means of obtaining a steady and uniform flow of water, and it is for this purpose that it is employed in the experiments here described.

Intermittent Springs.—The action of natural intermittent springs of water may be illustrated and imitated by means of the Mariotte's bottle, in conjunction with the toy called the vase of Tantalus, which is shown at *D* in Fig. 2. The vase of Tantalus is a vase or jar, the bottom of which is traversed by a tube having both ends open and the upper end bent downward to form a siphon. It easily can be

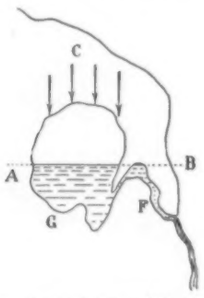


Fig. 1.—Natural Intermittent Spring

made at home by fitting a cork to a hole cut in the bottom of a tin pail, or biscuit box, and fitting to a hole bored in the cork a glass or rubber tube bent to the required form, as is shown in the right hand illustration of Fig. 2, where *E* is the pail or box and *F* the tube. The left hand illustration shows the conventional vase of Tantalus arranged in combination with a Mariotte's bottle to imitate the action of an intermittent spring. The Mariotte's bottle *A*, placed on a high support *C*, discharges through its outlet *B*, a constant stream of water into the vase of Tantalus *D*, which is placed on a lower support *C*. The water cannot escape from the vase of Tantalus until it has risen to the top of the siphon *F*. It will then begin to flow out through the siphon into the vessel *G* beneath and it will continue to flow until the level of the water in the vase has fallen to the level

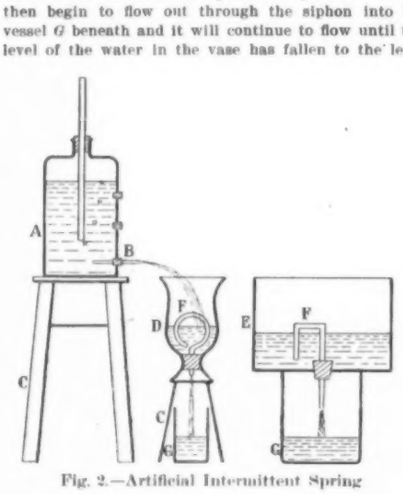


Fig. 2.—Artificial Intermittent Spring

of the mouth of the siphon. The flow from the vase of Tantalus will then stop, but it will recommence when the water level in the vase has again been raised to the bend of the siphon by the constant inflow from the Mariotte's bottle. With a siphon of large bore, combined with a small outlet and low head of water in the Mariotte's bottle, the water will escape in sudden gushes, at considerable intervals, from the vase, into which it is slowly and steadily trickling from the bottle. The action of a natural intermittent spring is quite analogous to this. The spring is the outlet of a natural fissure *F* (Fig. 1), having the form of a siphon and communicating with a cavity *G*, into which water slowly percolates, as is indicated by the arrows *C*. When the water attains

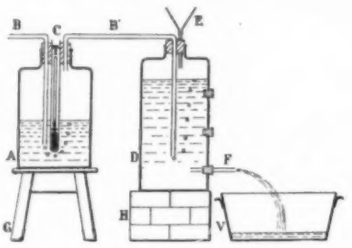


Fig. 3.—Cooling and Freezing Water

the level *AB* a large quantity is rapidly discharged, and the spring then ceases flowing until the water level has again been raised to *AB* by infiltration.

Cooling and Freezing Water.—Half fill with ether a wide-mouthed bottle *A* (Fig. 3) and fit to holes bored in the cork, two bent glass tubes *BB'* and a test tube *C* containing water and a thermometer. One of the bent tubes *B* dips into the ether and its upper end communicates with the atmosphere. The other tube *B'* extends only a little below the cork and is connected with the air tube of a Mariotte's bottle *D*, which is filled with water and has a large outlet *F*, closed by a cork. The height of the thermometer is noted and the cork is removed from the outlet of the Mariotte's bottle, which acts as an aspirator and draws a current of air through the tubes *BB'* and the ether in the bottle *A*. The rapid evaporation of ether thus caused produces a correspondingly rapid lowering of the temperature of the water in the test-tube, which is soon cooled to the freezing point, if the air of the

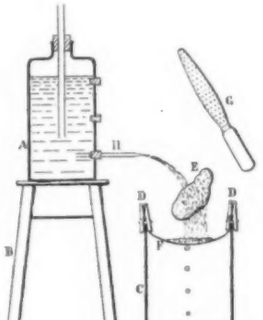


Fig. 4.—Analysis of Potatoes and Flour

room is moderately cool. In order to freeze the water, however, the Mariotte's bottle must be refilled two or three times and the flow quickly re-established. Time can be saved by providing the Mariotte's bottle with a funnel *E*. This experiment illustrates the method of cooling and making ice by the evaporation of liquefied ammonia and other gases.

Analysis of Potatoes and Flour.—Fig. 4 illustrates the use of a Mariotte's bottle in separating the starch from potatoes. The peeled potato *E* is rasped with the rasp *G* under the stream of water issuing from the tapered outlet *H* of the Mariotte's bottle *A*, and over a piece of muslin *F* fastened by spring clips *DD* to the rim of a deep vessel *C*. The broken starch cells, consisting chiefly of cellulose, are retained by the cloth, while the starch and water pass through. The starch grains slowly settle to the bottom of the vessel *C*. The water is then decanted and the wet starch is dried on a surface of plaster of Paris. Flour is analyzed by kneading it with the hand under the jet of water, which carries the starch into the receiving vessel, while the gluten remains as a plastic mass in the hand.

Cooling Laboratory Distilling Apparatus.—Fig. 5 shows a Bunsen burner *F* heating a retort *A*, of which the neck *B* enters that of a receiver *C*, which is cooled by a stream of water from a Mariotte's bottle *E*.

Cooling Woolf Bottles, Etc.—A Woolf bottle is a bottle with three necks which is used in preparing solutions of ammonia and other gases. In many cases continuous refrigeration of the apparatus is necessary. For this purpose a Mariotte's bottle filled with cold water may be employed, in the manner shown in Fig. 6. The Woolf bottle *A* contains water in which gaseous ammonia, flowing in through the left hand tube *B* to the bottom of the vessel, is being dissolved, while any excess of gas escapes through the right hand tube *B* to a second Woolf bottle (not shown). *C* is a safety tube which by admitting air prevents the pressure in the space above the liquid from falling low enough to cause an influx of liquid from the second bottle. The Woolf bottle pictured stands in a vessel filled with cold water which is frequently or continually replenished by means of the funnel *F* and the Mariotte's bottle *M*, while the uppermost and warmest stratum flows off through the outlet *G* to the vessel *R*.—La Science XXme Siècle.

Inheritance of Acquired Characters

IN the SCIENTIFIC AMERICAN SUPPLEMENT early in 1910 there appeared an account of some experiments by Dr. Paul Kammerer of Vienna, wherein the amount and distribution of pigment in the skin of certain lizards was modified by the conditions under which they were kept; and these modified patterns were reproduced in the offspring kept under normal conditions.

Dr. Kammerer has been continuing his experiments with lizards, and reported some further results at

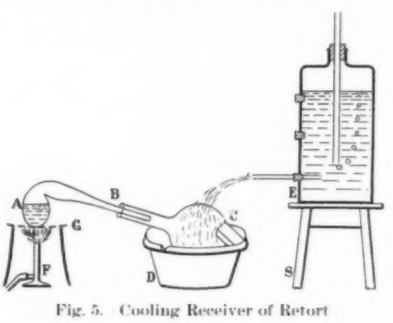


Fig. 5. Cooling Receiver of Retort

the International Physiological Congress held in Vienna this fall.

In the first series of experiments the modifications produced were in the reproduction of the animals. *Lacerta viviparous*, instead of laying eggs like the other members of the genus, bears its young ready formed. A number of these animals were kept in a warm chamber—25 deg. to 30 deg. C.—and these laid eggs which afterward hatched out. The first batch of eggs laid were without shells; the later batches had parchment-like shells resembling those of other species that normally lay eggs. A species that bears young was there modified by the temperature into one that bears eggs. The lizards that hatched from these eggs were placed in chambers of normal temperature; here, instead of reproducing by bearing young, as we should expect according to the prevailing biological theories, the females laid eggs again. Here then there appears to be a transmission to the offspring of a modification induced in the parents.

Another experiment was conducted with specimens of *Lacerta serpa*, which normally lays eggs with a soft shell. On keeping these in a warm room—30 deg. to 35 deg. C.—the later eggs were found to have

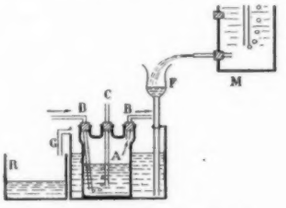


Fig. 6.—Cooling Woolf Bottles

rather hard shells. The lizards that hatched out of these eggs were kept at normal temperatures; but when they reproduced, their eggs were provided with the hard shells. Again there seems to be the transmission of a character that was acquired during the lifetime of the parent as a result of the action of some external factor.

The other experiments had to do with the modification of colors by increase in temperature, and were similar in their results to those already described in the article referred to.

Magnetic Crystals

An Interesting Investigation Into the Magnetic Properties of Crystals

By Dr. Victor Quittner

STRICTLY speaking, crystal magnetism is the oldest part of the entire subject of magnetism, for magnetite, lodestone or magnetic iron ore, which crystallizes in beautiful octohedra and rhombic dedecahedra, is the substance in which the phenomena of magnetism were first observed by the Greeks. After a method had been discovered of making steel magnets, very much stronger than natural magnets, the latter lost their practical importance and no further attention was paid to them. For centuries magnetic observations were confined to iron, which was regarded as the only magnetic substance.

In 1845 Faraday discovered that all substances, without exception, possess magnetic properties; generally, however, to so slight a degree that the most delicate instruments are required for their detection. Substances are divided into two classes: paramagnetic substances, which are attracted by both poles of a magnet, and diamagnetic substances, which are repelled by both poles. Both attraction and repulsion are produced by the magnetization of the body by the external magnetic field. When a paramagnetic body is placed between the poles of a powerful magnet, a south pole is developed in the body opposite the north pole of the magnet, and conversely. As each of these induced poles is of opposite sign to the pole of the strong magnet which is nearest to it, the body is

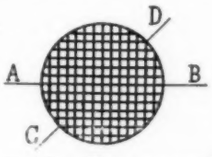


Fig. 1.—Grating of Iron Wires representing Plate cut from a Crystal of Magnetite

attracted by both poles of the magnet. When a diamagnetic body is placed between the poles of a strong magnet a north pole is developed opposite the north pole of the magnet, and a south pole opposite the south pole. Hence, the body is repelled by both poles of the magnet. The results may be expressed by saying that in paramagnetic substances the magnetization and the external field have the same direction, but in paramegnetic substances their directions are opposite.

A special class of paramagnetic substances, which are attracted very strongly by magnets, are called ferromagnetic. Only six such substances are known: 1, iron, in all of its modifications; 2, nickel; 3, cobalt; 4, magnetite or lodestone; 5, magnetic pyrites (Fe_2S_3), also called pyrrhotin; 6, the magnetic alloys of copper, manganese and aluminium, which were discovered by Heusler a few years ago. In a field of given strength ferromagnetic bodies acquire a magnetization millions of times stronger than that of ordinary paramagnetic and diamagnetic substances, and they also show many other peculiarities which warrant their segregation in a special class. One of these peculiarities is their behavior in fields of different strengths. In paramagnetic and diamagnetic bodies the magnetization is simply proportional to the strength of the external field up to the strongest

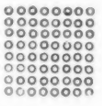


Fig. 2.—Arrangement of Molecules in Magnetite

fields that can be produced (46,000 gauss). In ferromagnetic bodies this proportionality holds only in very weak fields (less than one gauss). As the strength of the field increases the magnetization increases also, but less rapidly, until with a field of 1,000 to 3,000 gauss the magnetization attains a limit beyond which it cannot be increased by increasing the strength of the field. This condition is called magnetic saturation. Another peculiarity of ferromagnetic bodies, called hysteresis, consists in their consumption of energy and its transformation into heat when their magnetization is repeatedly and rapidly reversed. Probably paramagnetic bodies would exhibit the same property in fields of several million gauss, but such fields cannot be produced.

To return to magnetic crystals. All crystals may be regarded as magnetic, for every crystal, like every other body, is either paramagnetic or diamagnetic or ferromagnetic.

The extensive researches of Plücker and Faraday proved that the magnetic phenomena of crystals differ from those of other bodies. If a sphere of an uncrystallized orisotropic substance is placed in a uniform magnetic field, it remains an equilibrium in any position. But a sphere of calc spar, for example, placed in the same field turns so that its principal crystal-

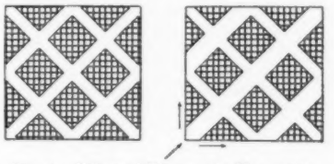


Fig. 3.—Effect of Fissures in Magnetite

lographic axis is perpendicular to the lines of magnetic force. Diamagnetic crystals of antimony and paramagnetic crystals of tourmaline, beryl, etc., behave like the diamagnetic crystals of calc spar. Other crystals, including those of bismuth, arsenic and zirconium (diamagnetic), spathic iron ore and uranium mica (paramagnetic), place themselves with the principal crystallographic axis parallel to the lines of force. The phenomena vary greatly with the different crystalline systems. Faraday was unable to explain them otherwise than by the assumption of a peculiar force which he called magne-crystallic force. This was no explanation but only the invention of a name.

A real theory of crystal magnetism, which explains the apparently very complicated phenomena in an exceedingly simple manner, was devised a few years later by Sir William Thomson (Lord Kelvin). I will attempt to present this theory in an easily intelligible form.

In every crystal, and in every anisotropic body in general, there are three special directions which are called magnetic axes. When the crystal is placed in a magnetic field, with any of its axes parallel to the lines of force, it behaves like an isotropic body, i. e., it acquires a magnetization (para or dia) in the common direction of that axis and the field. If this experiment is repeated with each of the three axes suc-

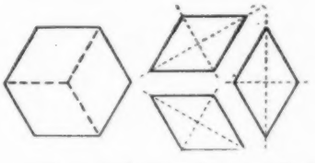


Fig. 4.—Hexagon Composed of Three Rhombs

cessively parallel to the lines of force, it is found that a field of given strength produces different degrees of magnetism in the three cases. Phenomena of very different character are exhibited when the axes are inclined to the magnetic field. In this case the axis along which the strongest magnetization can be produced draws, so to speak, the magnetization to itself, so that the direction of magnetization within the crystal is intermediate between this axis and the direction of the field. Consequently, the crystal turns and continues turning until the axis of greatest magnetic permeability; that is, the axis along which the strongest magnetization can be produced, is parallel with the lines of force. If the crystal is diamagnetic the result is similar, but in the final position of the crystal the axis of least magnetic permeability is parallel to the lines of force. In these experiments it is assumed that spheres or disks cut from the crystals are employed, as otherwise the position may be modified by the form of the body.

Thomson's theory gives a qualitative and quantitative explanation of all the phenomena observed in paramagnetic and diamagnetic crystals. It makes the assumption of any special force unnecessary, so that Faraday's magne-crystallic force has disappeared from the text books. This theory also makes it possible to deduce the magnetic properties of a substance from its crystalline form.

There are six fundamental systems of crystallization: 1, regular or tesseral; 2, quadratic or tetragonal; 3, hexagonal; 4, rhombic; 5, monoclinic, and 6, triclinic or unsymmetrical. From everything that we know of the other physical properties of crystals we should expect their magnetic properties to exhibit the same variety of symmetry that is shown by their crystalline structure. In the regular system, in which the three principal axes of crystallization are identical in every respect, we should expect the three principal magnetic axes, which coincide with the crystallographic axes, to exhibit equal capacities for magnetization. But if this is the case the direction of magnetization in any position of the crystal must coincide with the direction of the external magnetic force, and the crystal must behave in the magnetic field exactly like an isotropic or uncrystallized substance. We shall see later that this is not quite true in the case of ferromagnetic crystals of the regular system. Crystals of the tetragonal system have one principal axis and two or three secondary axes lying in a plane perpendicular to the principal axis. In this plane the crystal acts as an isotropic body, as the secondary axes are entirely similar to each other. According as the principal axis is more or less magnetisable than the secondary axes, and according as the crystal is paramagnetic or diamagnetic, it places itself with the principal axis in the direction of the magnetic field, or perpendicular thereto. In crystals of the rhombic, monoclinic and triclinic systems, there are three magnetic axes of unequal permeability, which coincide with the crystallographic axes only in the rhombic system. The crystal, if paramagnetic, places itself with the axis of greatest permeability in the direction of the field;

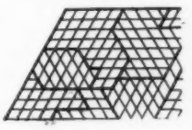


Fig. 5.—Arrangement of Elementary Rhombic Crystals in Pyrrhotin.

if diamagnetic, with the axis of least permeability in that direction. The following table gives the above mentioned facts at a glance:

Paramagnetic and Diamagnetic Crystals.

Crystalline System.	Magnetic Properties.
Uncrystallized Regular	3 equal magnetic axes. Isotropic in all directions.
Tetragonal Hexagonal	3 magnetic axes, only two of which are equal. Isotropic in the plane of these axes, which is perpendicular to the third or principal axis.
Rhombic Monoclinic Triclinic	3 unequal magnetic axes. Anisotropic in all directions.

For many years Thomson's theory comprised our entire knowledge of the magnetic properties of crystals, and it was generally believed that the theory applied to all crystals, including those of ferromagnetic substances, of which no exact studies had been made.

Our knowledge of the properties of ferromagnetic crystals are due entirely to the researches of Prof.

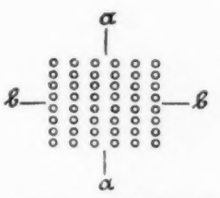


Fig. 6.—Arrangement of Molecules in Pyrrhotin

Pierre Weiss of Zurich, and his pupils, of whom the writer of this article was one. The researches were not undertaken solely with the view of exploring this very small field, but especially for the purpose of affording a basis for a theory of the very incompletely known and understood properties of iron and other ferromagnetic substances, for all strongly magnetic substances are composed of microscopic crystals. It seemed probable that a single crystal possesses properties of simpler character than those of the mass, and that when the properties of the elementary crystals had been determined, it would not be difficult to calculate those of the mixture of crystals which constitutes the apparently isotropic ferromagnetic substance.

The experiments were conducted chiefly with crystals of magnetite and pyrrhotin, also with small crystals of metallic iron which are occasionally found in

old railway rails, and in iron manufactured by Goldschmidt's thermite process. These crystals of iron are never larger than a few millimeters, and are consequently too small for exact measurements, but magnetite and pyrrhotin occur in fine, large crystals. Magnetite, chemically an oxide of the formula Fe_3O_4, crystallizes in the regular system, forming octohedra and rhombic dodecahedra, some of which are four inches in length. Pyrrhotin is a sulphide, which contains from 36 to 39 per cent of sulphur, corresponding approximately to the formula Fe_7S_8, or Fe_9S_{10}. It crystallizes in hexagonal pyramids and prisms belonging to the hexagonal system. Metallic iron crystallizes in small cubes belonging to the regular system. In some of the experiments the substances were employed in the form of small rods, but they were more generally used in the form of thin plates cut from the crystals in various directions. The diameters of the plates ranged from 1/25-inch to 4/5-inch, according to the size of the crystals. Only the larger plates could be employed for exact measurements. Very great importance was attached to having the plates perfectly circular and of uniform thickness throughout, hence very great care was taken in their production. Because of their fragility they were attached to glass plates with Canada balsam, and cover glasses were fastened over them.

A detailed description of the experiments and measurements would necessarily be too technical to have general interest. I will merely mention that two general methods were employed. In one the crystal plate was suspended in a horizontal position between the poles of a magnet, and the force with which the external magnetic field turned the plate was measured by the torsion of a spiral spring, by which the plate was suspended. In the other method a galvanometer was employed to measure the current induced in a coil of wire when the magnetized crystal plate was inserted in the coil. The results obtained by the two methods always agreed very closely. The first experiments, the results of which were published in 1896, related to magnetite. Considerable surprise was created by the discovery that magnetite, although perfectly regular in crystalline form, does not behave like an isotropic substance in the magnetic field. Upon a little consideration, however, this result does not appear so surprising, for Thomson's theory is based upon the assumption that, although the magnetization of a crystal may be unequal in different directions, it is in each direction proportional to the intensity of the field. We have already stated that although this law is obeyed perfectly (at least with any strength of field that we can produce) by diamagnetic and ordinary paramagnetic bodies, it is not obeyed by ferromagnetic substances, either isotropic or crystallized.

Hence Thomson's theory does not apply to ferromagnetic crystals, and the conclusions drawn from this theory with regard to the magnetic behavior of crystals of the regular system do not hold in the case of ferromagnetic substances. When a plate of magnetite, cut perpendicular to any one of the crystallographic axes, was placed in a weak magnetic field (31.5 gauss) it appeared perfectly isotropic, but when the strength of the field was increased the magnetization in the direction of either axis was found to be much smaller than the magnetization in a diagonal direction. When, however, the strength of the field was still further increased this difference gradually disappeared, until with a field of 1,000 gauss the magnetization became equal in all directions, and attained its maximum or saturation value of 482 magnetic units. The limit of saturation of good wrought iron is 1750. Hence the magnetic capacity of magnetite is 3.6 times less than that of soft iron, and nearly equal to that of nickel (490).

How can these phenomena be explained? Let us suppose that the crystal is composed of a framework of iron wires, one-third of which run parallel to each of the three axes. A plate cut from such a crystal, at right angles to any axis, would present the appearance shown of a rectangular network of wires (Fig. 1). When such a plate is magnetized in the direction of the axis *AB* the magnetic force, unless it is extremely strong, exerts an appreciable magnetizing effect only upon the wires which are parallel to *AB*, as it is very difficult to magnetize a thin wire transversely. Hence the magnetization affects only one-half of the wires of which the plate is composed. If, on the other hand, the magnetic lines of force run in the direction of the diagonal *CD*, both the wires parallel to *AB* and the wires at right angles to *AB* become magnetized. In this case only a component of the magnetic field acts upon each group of wires, but as each component exceeds 70 per cent of the entire strength of the field, the total magnetization produced is greater than in the former case, in which the field was parallel to the axis. It can be computed that this difference begins to manifest itself when the strength of the field is about 40 gauss. The vanishing of the difference in very strong fields is explained by the fact that in such fields even the wires which run transversely are magnetized to saturation.

Prof. Weiss has proved the general correctness of this explanation by constructing such an artificial plate of fine iron wires and showing that its magnetic behavior is identical with that of the plate cut from the crystal of magnetite. Of course, we are not to regard the crystal as being really composed of iron wires. The same results would follow if the molecules were arranged in strings like beads, and these strings were stretched in the directions of the three axes (Fig. 2). Here the molecules form the apices of small cubes and the structure is called a cubical spatial arrangement or "space grating" (Raumgitter). Hence the magnetic properties of magnetite bring us back to the old space grating theory, which has long been used for the explanation of other properties of crystals.

In the more exact investigation of magnetite which was undertaken by the writer in connection with these first experiments, other very remarkable phenomena were discovered in some plates cut perpendicular to the axes of magnetite crystals. In the weakest field of 31.5 gauss the magnetization was stronger along one diagonal and weaker along the other than along the axes. As the strength of the field was increased the magnetization along the weaker diagonal increased rapidly, attaining the value of the axial magnetization with a field of 63 gauss. As the strength of the field was further increased, the phenomena approached more and more closely to those of the typical plates first described.

How can we explain these remarkable results? Shall we assume that magnetite, which has always been regarded as a typical representative of the regular system of crystallization, belongs to that system only in appearance? After very thorough investigation I concluded that magnetite does crystallize regularly and that the results above observed are secondary phenomena, caused by fissures in the substance of the crystal. I picture the crystal crossed by numerous narrow fissures parallel to each face of the octohedron. If the fissures in the various directions are equal in width, a plate cut perpendicular to the axis would be represented by the left hand drawing of Fig. 3. In this case the fissures diminish the magnetization only slightly and to practically the same extent in every direction. If, on the contrary, the fissures in one plane are wider than those in another, a plate cut perpendicular to the axis will be represented by the right hand drawing of Fig. 3. Here it is evident that the fissures will diminish the magnetization along one diagonal more than that along the other and that the magnetizations in the directions of the two axes will be equal to each other. Increase in the strength of the field will diminish all of these differences.

Hence we see that the study of the magnetic properties of crystals gives an interesting insight into crystalline structure. The results thus obtained have been confirmed in many instances by observations in other fields of crystallography. For example, the presence of the fissures mentioned above is indicated by the fact that the cleavage planes of magnetite are parallel with the faces of the octohedron. A second proof is furnished by the fact that the octohedral crystals have perfectly smooth and glossy faces, but the rhombic dodecahedra always show distinct stripes running parallel with the longer diagonal of the rhomb. These stripes are the intersections of the internal fissures with the faces of the crystal.

Still more interesting results were obtained with pyrrhotin. It was discovered at the outset that pyrrhotin, which crystallizes in hexagonal prisms, is scarcely susceptible of magnetization along its principal axis. The magnetization in this direction is a thousand times less than in the plane at right angles to this axis, which may be called the magnetic plane. The three secondary crystallographic axes, which lie in the magnetic plane, are found to be magnetically unlike. The phenomena appear entirely irregular. In one plate the greatest magnetic permeability is shown by one axis, in another plate from the same crystal by another axis, etc. Here, therefore, we have again an apparent deviation from symmetry with the crystalline form. But, while in the case of magnetite the deviation is only apparent, in pyrrhotin it is real. The real magnetic properties of pyrrhotin are intelligible only upon the assumption that the crystal, apparently a hexagonal prism, is really a conglomerate of elementary rhombic prisms placed in three different positions (Fig. 4). We are not to suppose that the crystal is made up of three rhombic prisms, but that it is composed of minute rhombic prisms mingled in an irregular manner, so that one type preponderates in one part, a second in another, etc. (Fig. 5).

An attempt was made to isolate one of these elementary crystals. A crystal which showed a marked preponderance of one of the three elements was cut in two, one of the pieces which showed this preponderance to a still greater degree was again divided, and this process was repeated until a number of very small fragments were obtained, each of which was composed almost entirely of a single elementary crystal.

When a plate cut parallel to the magnetic plane of such an elementary crystal was examined it was found that magnetic saturation along one diagonal of the rhomb was produced by a field of a few hundred gauss, while in the perpendicular direction saturation was not complete with a field of 11,000 gauss. For the sake of completeness it may be added that in the direction of the principal axis, perpendicular to the magnetic plane, more than 200,000 gauss would be required to produce magnetic saturation. The limit of saturation of pyrrhotin is 47 units, about one-tenth that of magnetite and one-thirtieth that of soft iron.

These peculiarities of the elementary crystals can be explained by the simple assumption that the molecules are arranged according to a rectangular plan, but at unequal intervals along the three axes, so that they form long rectangular parallelepipeds. (Fig. 6.) It is evident that the magnetic strength would be greater in the direction of *aa*, in which the molecules are near together, than in the direction of *bb*.

In the elementary crystal of pyrrhotin, saturation in one direction is produced by a very weak magnetic field. When we consider that the fragments examined were very small and always contained some admixture of the elementary crystals of the other two types, we may be forced to conclude that, except for these obstacles, saturation would have been obtained with a still weaker field. Hence Prof. Weiss makes the bold conjecture that the elementary crystals of pyrrhotin are always, even in the absence of external magnetic force, magnetized to saturation in the direction of maximum permeability. This assumption is in harmony with Weiss's electronic theory of ferromagnetism, according to which magnetic saturation in one direction always exists in ferromagnetic substances.

This condition of magnetic saturation is not observed in larger fragments of pyrrhotin, which contain crystals of all three types, so mingled that they almost neutralize each other. When the large crystal is placed in a magnetic field, the magnetization of the elementary crystals cannot be increased, as these are already in the condition of saturation, but these crystals are turned more or less and the strength of the magnetization in the direction of the field depends upon the amount of this action.

Weiss's theory is not a vague speculation, but is supported by many exact measurements of the amount of hysteresis, the angle between the field and the induced magnetization, etc. We are tempted to extend to ferromagnetic substances in general the structure which appears to be possessed by pyrrhotin. We may regard each of the small crystals of which iron is composed to be always magnetized to saturation. As these crystals lie in all directions they neutralize each other, unless they are turned by an external magnetic field so that their magnetic axes become approximately parallel.

Hence we see that the study of the apparently recondite field of crystal magnetism on the one hand gives an interesting insight into the structure of ferromagnetic crystals (which can be extended by analogy to other crystals), and, on the other hand, suggests many valuable inferences concerning the nature of ferromagnetism and magnetism in general. —Prometheus.

Chemical Misnomers

THE word "oil," in its more comprehensive and everyday use, is made to include hydrocarbons, like petroleum, and also many substances that have an oily appearance, such as "oil of vitriol," which is not oil at all, but sulphuric acid. Strictly speaking, the mineral oils, including all petroleum products, are not oil, although we speak of "coal oil" and "kerosene oil," and the companies that supply us with those products are called "oil companies."

The highest authorities do not include in their lists of oils the mineral hydrocarbons, like naphtha, paraffin and petroleum, but treat only the two well-defined groups—fixed oils and fats, and the essential or volatile oils.

"Copperas" is a conspicuous example of chemical misnomer. It is not copper, but sulphate of iron. "Salt of lemon" has nothing whatever to do with the fruit of the lemon-tree, but is potassium binoxalate, or potash treated with oxalic acid.

"Carbolic acid" is no acid, but a phenol. In structure it is allied to the alcohols, and has only slight acid properties. "Soda-water" shows no trace of soda; "sulphuric ether" contains no sulphur; and "sugar of lead" is entirely innocent of sugar. "Cream of tartar" has no cream, nor "milk of lime" any milk. "German silver" is not silver at all, and "black lead" is graphite, not lead. "Mosaic gold" is a sulphid of tin.

These misleading names have come down to us from the vocabulary of an early and inexact chemistry. As popular science extends, the old terms are yielding to the more scientific nomenclature.

Power Production from Solar Radiation*

A Plan for the Exploitation of Natural Sources of Power

By R. A. Fessenden

THE problem of the commercial utilization for the production of power of the energy of solar radiation, the wind, and other intermittent natural sources, is a double one. The energy of the sources must first be changed so as to be available in form; it must next be stored, so as to be available in time.

As regards the second of these two points, one of the expedients which perhaps naturally suggests itself, namely, the use of storage batteries, is commercially quite out of the question owing to its high cost. The method actually employed is storage by gravity. Two reservoirs are constructed, one at a considerably higher level than the other, and the water is first pumped up, and then allowed to fall as desired, and to actuate a turbine. A cubic yard of water falling through one thousand feet is capable of giving out energy equivalent to one horse-power hour. If we consider the possible plans for carrying out this project, the arrangement which perhaps first occurs to us is that of building a tank at the top of a tower. But this is impracticable, for either the volume of water required is excessive, or else the height of the tower becomes prohibitive. The problem assumes more promising form if the upper tank is built on the level of the ground, and the lower tank at the bottom of a deep shaft. Estimates were obtained from three different firms of mining engineers in Philadelphia, which showed that a shaft one thousand feet deep could be dug, properly timbered, and the necessary chambers hollowed out at the bottom, and ferro-concreted, so as to withstand the water pressure, at a cost not to exceed two dollars per cubic yard. Assuming two weeks' storage and an efficiency of 75 per cent, the capital cost per horse-power will be $37.50. Assuming interest at four per cent, and depreciation at two per cent, the annual cost of water storage facilities, exclusive of the pumps and turbines, will therefore be approximately $2.25 per horse-power.

Tenders for the pumps and Pelton turbine wheels for a 3,000-horse-power plant show that the cost of these is approximately $12.50 per horse-power. Allowing four per cent interest and four per cent depreciation, this makes a total annual cost for pumps and turbines of one dollar per horse-power. The total annual cost of storing one horse-power by the negative gravitational method is, therefore, $1.00 + $2.25 = $3.25.

As regards efficiency, water storage has the advantage over the electric accumulator. The energy efficiency of a storage battery is generally given as about 65 per cent, i. e., approximately 80 per cent on charge and 80 per cent on discharge.

With water storage it is safe to assume an energy efficiency of 89 per cent, both at charge and discharge, giving a net efficiency of 80 per cent.

We have next to consider the method of obtaining the energy from the sources. There are two main sources available, solar radiation and the wind.

To obtain an idea of the amount of power which solar radiation represents under normal working conditions, a long-continued series of measurements were made by Prof. Very, who found that the amount of solar energy received per annum at the earth's surface on an area one hundred meters square in the places indicated is on an average as follows:

	Kilowatt hours.
Central Europe	4,000,000 to 6,000,000
Northern United States	5,000,000 to 7,500,000
Southwestern United States	10,000,000 to 15,000,000

As regards the amount of power to be derived from the wind, tests made during a period of one year on a steel tower 420 feet high at Brant Rock, Mass., showed an average of 800 horse-power at the shaft of a windmill of 300 feet equivalent diameter. These figures are about 30 per cent higher than those obtained by Danish experimenters; the difference is probably to be attributed to the fact that the Danish experiments were made near the surface of the ground.

To utilize solar radiation, it is proposed to use a solar tank containing water heated to about 100 deg. C.*. The steam so generated at atmospheric pressure is to drive a low-pressure steam turbine, which operates the pump. Low-pressure working is resorted to, because with this arrangement the transparent top of the chamber containing the working fluid can be made very thin, and has to withstand practically no pressure. The transparent roof is designed of double thickness, and contains wire netting imbedded in the glass as a protection against hail. The working fluid flows in a thin stream across the bottom of the solar tank, and the thickness of the stream is varied automatically with the amount of radiation received.

The working fluid contains a small amount of potassium dichromate. The glass forming the transparent covering contains a small amount of sulphate of iron, sufficient to give it a pronounced greenish tinge. It has been found that by this means the glass can be made totally reflecting for wave lengths corresponding approximately to those emitted by the heat of water, while remaining fairly transparent to the radiation from the sun. The thermodynamic efficiency of the system is approximately fifteen per cent, and it is anticipated that about ten per cent would be obtainable on the shaft of the steam turbine.

From tenders made, the costs per horse-power have been found approximately as follows:

Solar tank	$10
Low-pressure steam turbine and condenser	$25
Dynamo	$15

Adding to this the cost of the pumps and the water turbine, we obtain a total of $62.50 for the first cost per horse-power for the machinery, exclusive of the reservoirs. Allowing interest at four per cent, and depreciation at four per cent, and two per cent for labor, we obtain a value of $6.25 per annum per horse-power as the cost, exclusive of the reservoirs. Adding in the cost of the reservoirs, we find $8.50 as the actual cost per horse-power.

It will be seen that these figures compare favorably with the present cost of producing power from coal. Moreover, these estimates are excessive, for the reason that it is proposed to operate a windmill plant in conjunction with each solar radiation plant. The load will thus be greatly evened, and a much better all-day and all-year efficiency obtained, because the wind is, as a rule, more effective during cloudy weather and at night time, i. e., at the time when solar radiation is diminished or absent. The storage reservoirs employed in connection with this solar plant are, of course, available without additional cost for the wind-power installation.

Assuming a solar tank 200 meters square, we may expect to receive a total radiation of approximately twenty million kilowatt hours per annum. Assuming an efficiency of ten per cent, we should get two million kilowatt hours at the steam turbine shaft. On the basis of a seven-hour day, the solar radiation plant would yield an average of 800 horse-power. Adding to this the energy derived from the windmill, we obtain a total of about 1,500 horse-power.

The figures given above are for average conditions. The location of the first plant is, on the whole, much more favorable. It is situated at a copper mine, where the vertical shaft is already available, and where worked-out lateral chambers are used for the lower reservoir. A portion of the pumping machinery also is provided at the mine, thus further reducing the cost of installation.

The following is a comparative estimate of the costs of producing one horse-power for one year by steam, gas engine, water power at Niagara Falls, and the present method. The estimates are based on a plant having a capacity of 100,000 horse-power, operating under average conditions:

Method of generating power.	Cost per horse-power per year.
Steam	$15.00
Gas engine	10.00
Water power at Niagara Falls	3.75
From intermittent natural sources	4.50
Water power under exceptionally favorable conditions	2.50

It will be seen that while this method of producing power is much cheaper than a steam or gas engine, it is approximately on a par with water power under fairly favorable conditions, such as prevail at Niagara Falls. This is because in the present method and with water power the capital first cost is the determining factor. The capital first cost per horse-power by the present method using a solar tank is approximately $62.50; and using windmills in conjunction with the solar tank, approximately $45. The capital first cost at Niagara Falls is approximately $40.

The new method gains chiefly from the higher fall and from the cheaper and more efficient water motor, also from the fact that only one-seventh as much water has to be handled, and that there are no dams to build or large buildings to erect. It loses from the fact that a pump has to be supplied, also a steam turbine and solar tank or windmill. The method, therefore, may not be of so much value in places favorably situated for obtaining water power. Localities so favored are, however, comparatively few in number.

* Abridged from a paper read before the British Association for the Advancement of Science.

* We are not aware that a temperature much above 65 deg. C. has ever been obtained in any published experimental work.—ED.

The Argon Process

IN a paper presented to the Academie des Sciences, M. Georges Claude shows that it is easy to obtain argon in the laboratory by using oxygen furnished by the liquefaction of air to begin with. In practice such oxygen is above 95 per cent pure, and the principal impurity, at least with the oxygen which the Claude process procures, is argon, whose volatility is intermediate between those of oxygen and nitrogen. Only a lack of tightness in the oxygen compression apparatus would give a predominance of nitrogen. Oxygen at 96 per cent, for instance, contains normally more than 3 per cent of argon, and hence it is a raw material which is three times as rich as air for the argon process. Besides, the oxygen is much more easily absorbed than nitrogen. In the method used by the author, he absorbs the oxygen by means of copper and the nitrogen by that of magnesium. We can regain the copper in the metallic state, and the expense for magnesium is small owing to the low percentage of nitrogen. The oxygen is taken from the steel bottle by means of a suitable expansion valve. It is sent into a copper tube filled with reduced copper and heated to a low redness. The residue traverses a smaller iron tube full of powdered magnesium heated to redness, and then an oxide of copper tube designed to absorb the hydrogen due to any initial dampness of the copper or oxygen. The absorption of the oxygen by copper takes place very rapidly and would cause the fusion of the oxide if the delivery of gas were too high, but we should avoid such fusion in order to keep up the porosity of the mass, this allowing of an easy recuperation of the metal by a hydrogen treatment, so that in practice we use continually the same tube. For instance, he uses a copper tube 60 centimeters (23.6 inches) long and 6 centimeters (2.36 inches) diameter, heated over the whole length from the start of the operation by the flame of four Bunsen burners of the butterfly type. The tube is charged with 2.5 kilogrammes (5.5 pounds) reduced copper mixed with some fine turnings so as to increase the permeability of the mass. An iron tube is charged with magnesium, the tube being 40 centimeters (15.7 inches) long and 3 centimeters (1.18 inches) in diameter, heated to redness on a grating. The copper oxide is placed in a silica tube 30 by 2 centimeters (11.8 by 0.78 inches) kept at low redness. This apparatus allows of treating 3 liters (85 cubic feet) of oxygen per minute and thus we obtain 4 to 6 liters (113.2 to 170 cubic feet) of argon per hour during 2 hours, or 8 to 12 liters (226 to 339.7 cubic feet) before exhausting the copper. The best method of following the operation is to take at the start the densities of the gases collected until we obtain the density due to argon. No new observations need be made before the last half hour, for the operation is very regular and the absorption quite complete. The recuperation of the copper by hydrogen in the same conditions of heating as above can be completed in less than 1½ hours.

The Pennsylvania Railway Company announces that it has instituted a new plan of training men to maintain and operate signals. It has appointed four signal apprentices who are college graduates. The different divisions of the lines east of Pittsburg have started signal schools, where experienced men give instruction to the division signal employees. The importance of this step is indicated by the fact that whereas in 1902 there were but 7,891 interlocking functions in operation on the lines east of Pittsburg, in 1908 this number was 20,725. These functions are operated by 8,792 levers. A total of 12,408 signals is in service, covering 3,385 miles of road, or over 70 per cent of the mileage. Signal apprentices will serve a three years' course, and will then be eligible for the position of assistant signal inspector in the signal engineer's office. After attaining this they will be considered for appointment to the following positions: Assistant supervisor of signals, supervisor of signals, inspector, assistant signal engineer, and signal engineer.

The "Holy Mountain"

Exploring in the Sinai Peninsula

By Harold J. Shepstone

ALTHOUGH the famous Monastery of St. Catherine, on Mt. Sinai, is visited every year by a number of Greek and Russian pilgrims, the Sinai Peninsula may be said to be little known, either to Europeans or to Americans. Yet, its ancient history renders it one of the most sacred places in the world, while its precipitous mountains, wonderful gorges, strange fertile oases full of Bedouin life, and its monastery, perched high up the barren heights, make the region one of untold interest to the traveler.

In view of these facts an account of a somewhat extensive tour recently made in the Peninsula may not be without interest. Our party numbered four, each hailing from a different country. One was a member of the American Colony in Jerusalem, who acted as photographer and with what result the accompanying photographs must testify. After getting our permits from the Egyptian War Office we took boat from Suez. We also had letters of recommendation to the convent on Mt. Sinai from the Greek Convent of Cairo. As we steamed out of the harbor of Suez looking westward toward the mountains of Atakah, there could be seen the probable locality where the Israelities crossed the Red Sea.

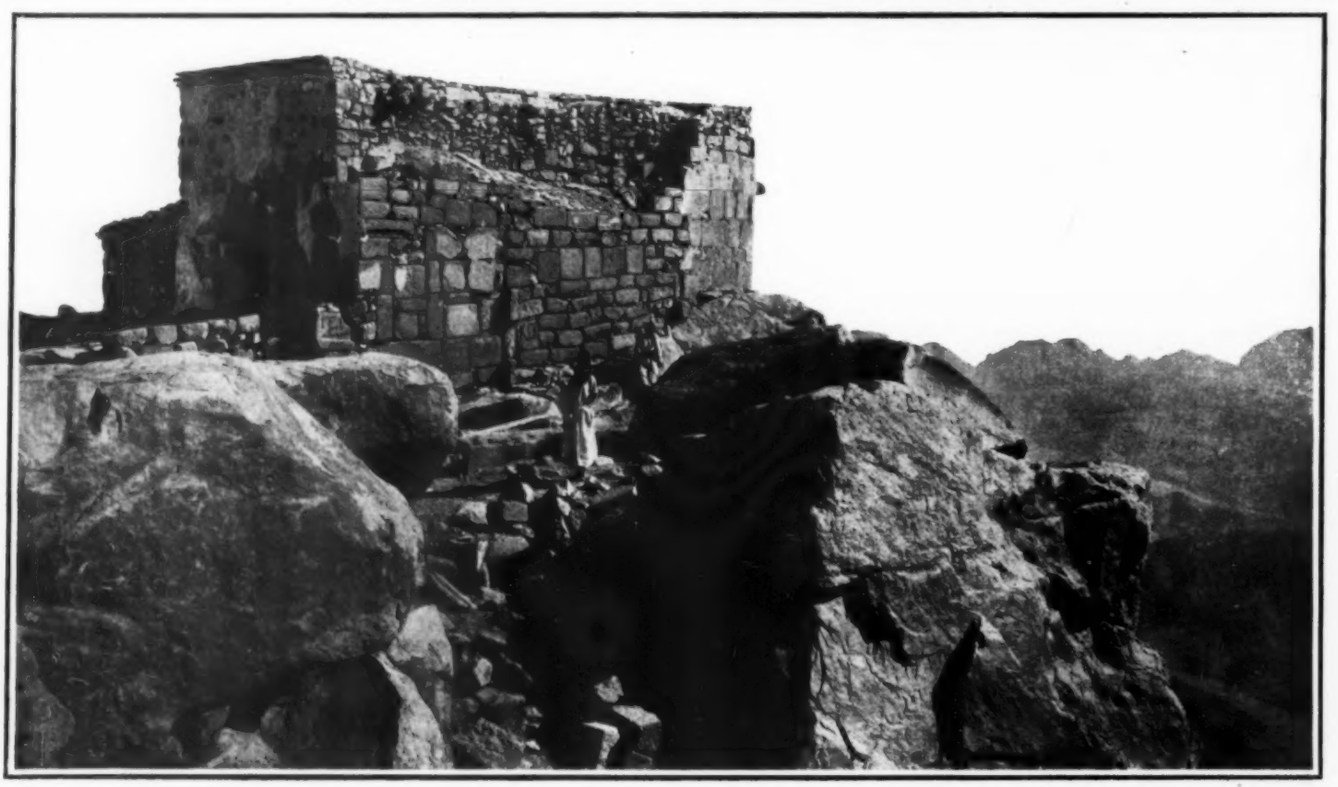
Our steamer had seen forty-nine years of hard service, and bore marks of it on every plank, every door lock seemed to be worn out, so that there was continual banging day and night. When the vessel pitched and the stern was raised out of the water, the rudder shook and vibrated as if it could not stand a second wrench. Some few hours out we lost the anchor in thirteen fathoms of water. This was daringly recovered by an Arab diver. He was let down on a leaden weight, attached a hook to the anchor, which was then drawn up. In all the man was three minutes under water. The deck of the vessel was full of devout Mohammedans making their pilgrimage to Mecca. There were 120 of them, and they seemed enough, yet on the previous voyage this same vessel carried 500 of these pilgrims, who by force took possession of the first and second-class accommodations. The crew could offer no resistance, as the pilgrims were well armed.

Our first view of Sinai was at early morning as our steamer entered the harbor of Tor. The sun was just rising over the highest peak, and it was very impressive and beautiful. The little harbor is protected by a natural breakwater of two coral reefs, with just sufficient space between them to allow a boat to enter. Tor is the great quarantine station of pilgrims returning from Mecca. There is an excellently arranged series of buildings for the use of the quarantined pilgrims, and the fumigating and disinfecting quarters are colossal structures, very modern and quite up to date. This international quarantine station is enlivened during the period of the detention of pilgrims by many thousands of "the faithful" camping out, if they are too numerous for the rooms.

In 1904 there were as many as 17,000 here at one time. There must elapse ten days without a death before the pilgrims are allowed to proceed on their journey, and there were many deaths among this great multitude, so that it appeared as though they never would be able to proceed. The pilgrims then agreed that for the next ten days there should be no more deaths. But after their departure a strong wind blow-

RESTING AT THE OASIS OF EL WADI, NORTHEAST OF TOR, AND PREPARING TO CROSS EL KA'A, OR WILDERNESS OF SIN

HILL OF AARON, SO CALLED FROM THE TRADITION THAT ON ITS SUMMIT THE GOLDEN CALF WAS SET UP



THE SUMMIT OF JEBEL MUSA, WHERE MOSES RECEIVED THE TEN COMMANDMENTS

ing and shifting the sand where the tents had stood revealed the ghastly sight of the remains of several pilgrims, who having died, had been buried in the sand under the tents by their comrades. The village of Tor will no doubt dwindle into insignificance now, since there is a railroad connecting the Damascus and the Haifa railroad with that of Medina, and most of the pilgrims will surely prefer that route. But one only hopes that the same energetic measures for preventing the spread of cholera, plague, etc., by these returning hordes of devotees will be adopted by the Turkish authorities at the quarantine station on the Mecca railroad, otherwise the health of Europe will be greatly imperiled.

As soon as we dropped anchor in Tor harbor a sailing boat came out with the superior of the Greek convent there to assist us in landing. He told us that our camels were ready, and we could at once commence our inland journey. When we got to shore, however, we found that a contract had to be drawn up between us and the Bedouin Sheiks, and that trivial affair took no less than three hours to complete satisfactorily. As the Bedouins take it in turns to escort parties to Mt. Sinai, and every one claimed it was his turn, it took additional time to finally settle their fighting and shouting.

The Sinai Peninsula, it may be added, is bounded on the north by the desert of Tih, or the Wilderness of the Wandering, on the south by the Gulf of Suez, and on the east by the Gulf of Akaba. It is governed by the Intelligence Department of the Egyptian War Office. One officer is stationed at Khalat el Nakhl, and another at Tor. There are only about 5,000 to 6,000 inhabitants, as that is all that can be supported on this barren peninsula. The Arabs are divided into tribes, each tribe having a Sheik who wields considerable authority. The sacred associations of the region draw a number of pilgrims, chiefly Russian and Greek, to the Convent of Mt. Sinai. These, of course, need camels to carry them and their water and food, so in this way a number of the Bedouins gain a livelihood. Many own a few palm trees either on the plain or in the Oasis of Firan. They take the dates to Suez on camelback, and trade them for corn and millet. Although the mountains are so barren, yet many shrubs and plants that grow, being aromatic, are much liked by camels, goats and sheep, and a fair number of goats and of sheep are raised.

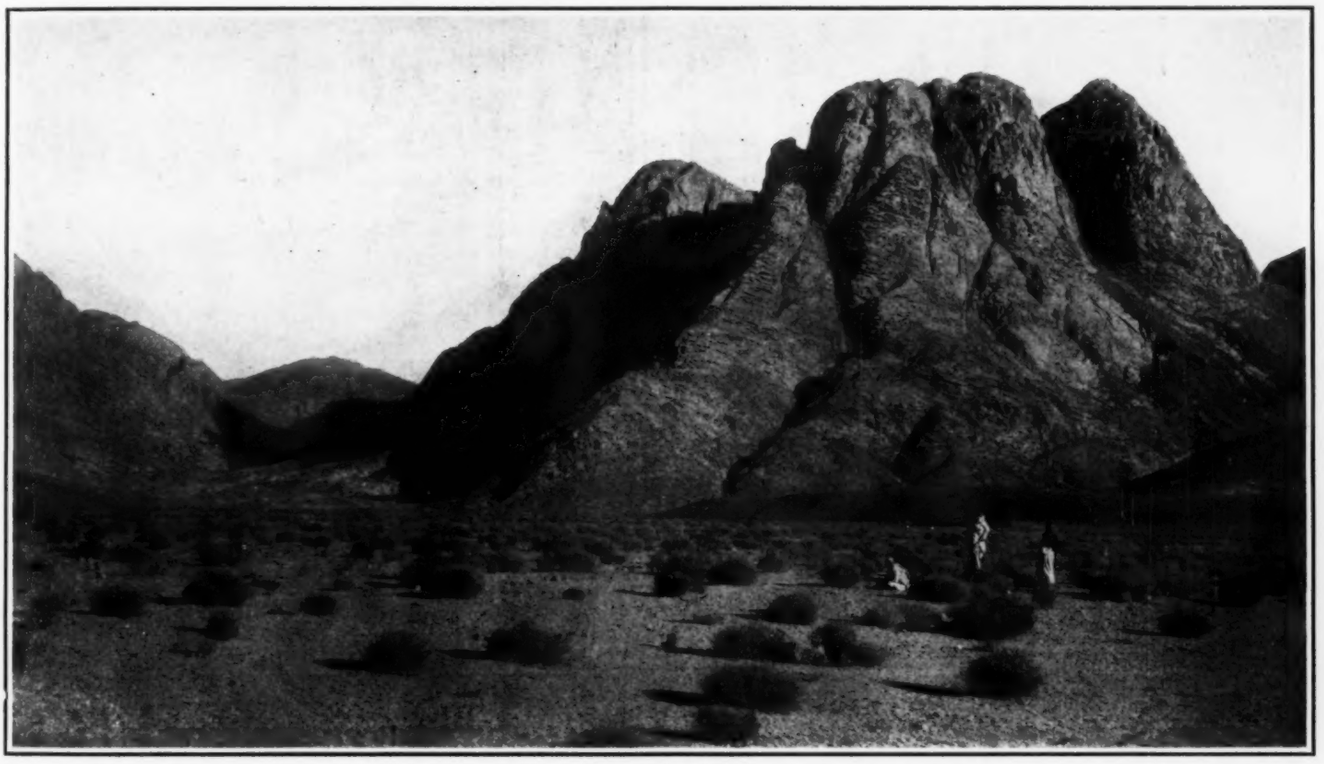
We were very cordially entertained at the Greek convent at Tor during the few hours before our start. As soon as we arrived we were taken into the comfortable reception room, and the usual jelly served. A tray is brought in on which was placed a glass of jelly, several spoons, and a little glass of date brandy, and you are supposed to take a spoonful of jelly only. Once one of my friends, to whom it was passed, and being unacquainted with the customs, thought that he had to finish the whole glass of jelly. But after five or six spoonfuls, finding that impossible, the host seeing the predicament my friend was in, came to the rescue and explained the manner of procedure.

It was about noon by the time we had our loads arranged, chosen our riding camels, and got started. We struck across the desert or plain of El Ka'a in a northeasterly direction, aiming for Wadi Hebran. The wind was blowing hard, and the sand stung our faces considerably. After traveling two or three miles we came to the Oasis of El Wadi, where we stopped long enough to water the camels and to fill our water skins from the well of good water. From here the ground became less sandy until it finally grew hard and gravelly. This continued until we reached the foot of the mountains just as the sun was disappearing, when we camped for the night.

The view from our tent when we woke early in the morning will never be forgotten. The peak of Mt. Serbal, so rugged and imposing, was lit by the sun which was rising over Jebel Katherine. The plain was studded with large boulders of granite which had been washed down by the winter torrents, and here and there grew a shittim tree. Soon after moving from our camp we came to the entrance of the valley of Wadi Hebran, and found on the steep cliffs of the rocky ravine several Sinaitaic inscriptions. These were mostly Nabataean, cut by a people that inhabited the rock-hewn city of Petra, and worshiped sun, moon, and stars.

The road along this Wadi is quite good, and during the spring there is a stream of water here. Even as we passed, in September, there was water flowing for some distance from the fountain head, and all along the sides of the little brook grew luxuriant vegetation. At noon time we rested under the shade of a group of palm trees watered by a little spring. This was the most beautiful part of the Wadi. Here were supported several Bedouin families. They were just

THE NORTH END OF THE GULF OF SUEZ. SCENE OF THE PLACE WHERE THE ISRAELITES CROSSED THE RED SEA



WADI ER RAHA

THE "HOLY MOUNTAIN"

gathering their crop of dates. The men easily climb the trees and cut the dates off in big clusters. These are picked off the stems and dried in inclosures, fenced in with palm branches.

As we ascended, during our ride in the afternoon, the valley became more sterile, with no water and little vegetation. The road, too, was rough, and at a height of 3,000 feet we came upon our first sight of the only remains of former habitation. These were the Nawamis, a sort of low stone buildings which the Bedouins attribute to the Israelites. The tradition is that for protection against a plague of mosquitoes they were built by them, but scientists think they were either graves or huts of the ancients.

As we wished to visit Wadi Firan, we left the main route to the convent and camped for the night in a desolate valley, with no water and no verdure, except some juniper bushes. During the night we heard the laughing of the hyenas. They are quite numerous here, and many of the graves of the Bedouins which we passed had been dug into by these repulsive animals which prey on corpses and carrion. In these mountains wild goats are found, and occasionally leopards. Before sunrise next morning we were off to the Oasis of Firan, determined to return to our camp that night. We were much struck by the strange

suffering from fever, caused probably by the stagnant water in some of the gardens, and a diet consisting almost entirely of dates. By noon time we had traversed almost the entire oasis, and came to the ruins of an old convent. This was one of the great centers of the Anchorites in the early centuries, and the sides of the valley are full of their tombs. They came to this spot, as it is at the foot of Mt. Serbal, which the earliest traditions affirm to be the Sinai of the Bible. Later, as the monks of Jebel Musa, at the Monastery of St. Catherine, became powerful, they claimed that around their locality transpired all the acts connected with the giving or the law. Eusebius, the earliest Christian historian, gives the Oasis of Firan as the battlefield between the Israelites and the Amalekites.

On our return to camp we simply retraced our steps, returning by the same route we had come, and next morning set out for the Monastery of St. Catherine. As we were traveling along, suddenly one of the Bedouins began examining the ground and following some track. He then assured us that a camel of his had passed along there the day before. They can tell their own animals by their foot prints, and as they allow them to roam at will over the mountains for months at a time, they get very expert in tracking them when they need them. They always keep within

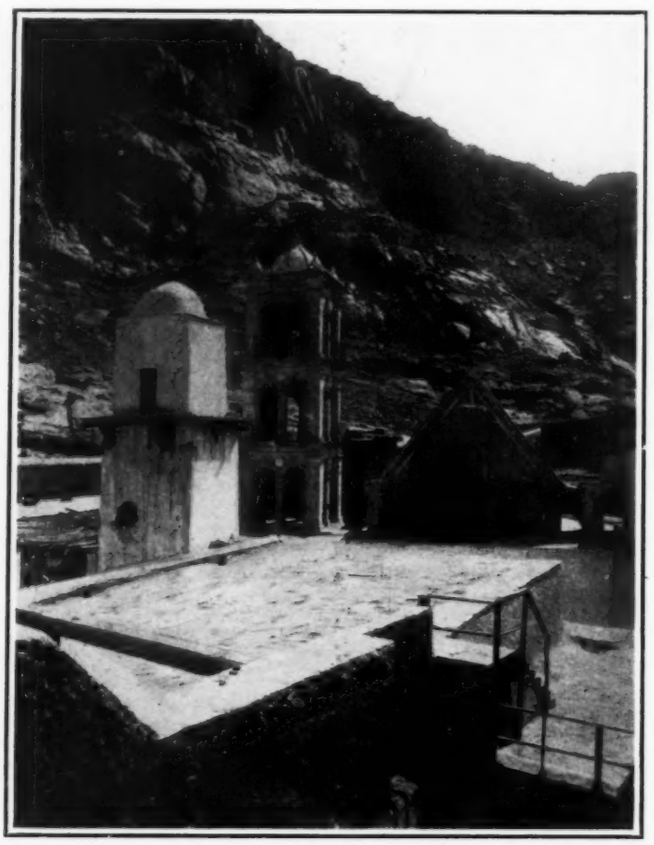
protects it, and the fearful massacres which had occurred at intervals here are no longer feared.

One of the monks was appointed our guide up Jebel Musa (mountain of Moses), which we undertook on the early morning of the second day after our arrival. We ascended by the pilgrims' steps, a steep path built by the monks, each step being a slab of granite. A little chapel on the way up marks the spot where the Virgin appeared to the monks as they were deserting the monastery on account of a plague of vermin and promised them deliverance if they would return. They did so and found that the tormenters had disappeared. But tourists agree that they have since returned. Continuing our upward way we next come to an archway through which the path leads. Long ago a hermit named St. Stephenous zealously guarded the gate, and would allow no one to ascend the Holy Mountain unless he could prove his worthiness and that his record was good. If this was proved he would administer the sacrament and allow the pilgrim to ascend. One day he was found at his post, but lifeless.

The path, after twisting in and out among huge boulders of granite, suddenly opens on a small plateau with a gigantic cypress tree, and a round mound or hill in the center. The monk told us that here Moses gathered the elders of Israel together. Here also is a

WADI ISLA, A GRAND AND ROMANTIC GORGE.

At point where view was taken the defile is 12 feet in width, while the rugged granite walls on either side are hundreds of feet in height.



VIEW INSIDE THE MONASTERY OF ST. CATHERINE, SHOWING CHURCH OF THE TRANSFIGURATION AND THE MOSQUE SIDE BY SIDE

THE "HOLY MOUNTAIN"

seams of black diorite, in the gray and red granite slopes. These seams run invariably from north to south, and the dividing line between the different colors is as marked as if it had been cut with a knife. As we neared Wadi Firan we could see where the valley narrowed to only a few yards in width. This was at El Buwab, the Arabic for "little door." Undoubtedly this pass was utilized by the Children of Israel in their journey to Sinai, as there is no other route practicable for a large body of people.

Soon after this, as we turned a bend in the valley, a most exquisite picture met our eyes. It was the beginning of the Oasis of Firan, the veritable "Pearl of Sinai." Out of the apparently parched desert sprang a beautiful stream of water, making an Eden of the next seven miles of the Wadi. No one can appreciate such a change, such a jump from sterility into fertility, unless they have actually traveled the weary desert and come to such a haven. Our ride through the palm gardens was very enjoyable, as they were full of Bedouin life. At no other season of the year could we have witnessed the date harvest which was just being gathered. After the dates are gathered almost all the Arabs leave the gardens and seek the hills and plateaux where pasture is obtainable for their animals. We noticed that many people in the oasis were

a few hours' journey from a spring. The road was very rough and tedious at Nabk el Haweh, but we were well repaid when we got to the summit of the defile. The view was grand and commanding. Jebel Musa, Jebel Katherine, and many other peaks loomed into view. From here our goal was in sight. A ride of a few hours more brought us to the hospitable Monastery of St. Catherine. We pitched our tent in the convent grounds, and at once went to pay our respects to the monks, and to present our letter of introduction. They had already got word of our coming, so were on the lookout for us.

The monastery or convent, as it is generally called, although only monks reside here, is built in a narrow valley, at the foot of Jebel Musa. It has almost the appearance of a fortress, having a massive wall surrounding it. And such it was, for we learn that Justinian built a fort on this site in the fourth century, expressly for the protection of the monks. He also strengthened them by a present of 100 Roman and 100 Egyptian slaves, with their wives and children. The descendants of these very slaves, the Jebeliyeh, still live at the convent and serve the monks, although they have adopted Mohammedanism. There are now about twenty-five monks living here, Greeks from Cypress or Crete. As the church is Greek Orthodox, Russia now

chapel said to mark the cave where the prophet Elijah rested when fleeing from Jezebel, and where he heard the still small voice. From this point to the top the ascent is very steep, but thanks to the monks, it is not difficult, as they keep the steps in repair. The whole summit of the mountain is a huge mass of solid granite. The upper point is over 700 feet high, and here is pointed out the rock where Moses saw the glory of God pass by, and where he received the Ten Commandments. Some one described the view from here as looking upon an enlarged section of the moon. It is well put, for no greater desolation or bleakness could be found anywhere. Jebel Katherine, close by, is very imposing. It is the highest peak of the range. Toward the east are seen chain after chain of somber looking mountains, and beyond the Gulf of Akaba.

After descending to the monastery we spent the rest of the day in visiting the locality where Aaron made the "Golden Calf," and then on the Plain of Er Raha. This is a broad, fine plain at the foot of Jebel Safsaf and Jebel Musa, where Israel must have camped while Moses ascended Sinai. The following morning we devoted to the monastery. The present entrance is through a small, heavy iron door in the western wall. Then comes a few feet of a low passage, and another similar door. These would afford considerable resist-

ance in case of a siege. Until recent years visitors were admitted to the monastery by means of a rope, which was attached to a person, who was then drawn up over the wall.

On entering we were much surprised at seeing the minaret of a mosque side by side with the bell tower of a Christian church. We learned that the erection of the mosque was a diplomatic move on the part of the monks to save themselves from massacre by the Mohammedans, since through their care of the mosque they thus obtained the favor of the Islams. The church is an early Christian structure built in memory of the Transfiguration of Christ. The mosaics which adorn the apse are very old and very valuable. The monks took us to one side, brought a table, and with an air of great mystery opened a small marble sarcophagus, out of which they took the skull and one hand of St. Catherine, the martyr of Alexandria. These remains were bedecked with most costly jewels. Each of us was presented with a souvenir ring taken from the coffin.

We next visited the Chapel of the "Burning Bush," where we had to take off our shoes, for "it was holy ground." The library was of most interest to us, as this is where Prof. Tischendorf discovered, in 1844, the Codex Sinaiticus, a Greek manuscript of the Old and the New Testament. It dates from 400 A. D. He was a German scholar and devoted his whole life to the discovery and the study of ancient biblical manuscripts. On this errand he visited all the libraries of the East, but quite unexpectedly found this, the "pearl of all his researches," in the Sinai convent. He saw some leaves of parchment in the waste paper basket, and was told that two similar lots had been burned. Among them were parts of the Greek Septuagint, the oldest-looking manuscript he had ever seen. He was allowed to take what he wished of them and got forty sheets; but he displayed so much joy with his gift that the monks suspected their value and would give him no more. On his return to Europe he tried by every means to procure the remaining sheets, but without success. Fifteen years later he returned to Sinai armed with letters from the Czar. On knocking at the door of the convent, one of the monks put out his head over the ramparts, and after receiving his letter the monks lowered the rope and hoisted him up. Still he accomplished nothing and was preparing to leave, when the steward of the convert invited him into his cell and showed him a bundle of old manuscripts, which he found was just what he was searching for. This time he concealed his joy, and carelessly asked if he could take them to his room while he found out their real value. They were given to the Czar and are now in the library of St. Petersburg.

Our return to Tor was by a different route from the one we came by. We went south and followed Wadi Isla. This is the most picturesque gorge in Sinai, especially for the grandeur of the precipitous rocks or cliffs that inclose it. They rise on either side, in some instances two to three thousand feet. The bed of the torrent is narrow, not exceeding five yards in some places, and through this rushes a mighty volume of water after a rain storm, sweeping all before it. We camped for the last night of our desert journey at the mouth of this gorge. It was most oppressive and hot. At midnight the thermometer registered 100 deg. F.!

LIBRARY OF THE MONASTERY OF ST. CATHERINE WHERE THE CODEX SINAITICUS WAS DISCOVERED BY TISCHENDORF

The manuscript held by the monk is the well-known Evangelium Theodosianum which dates back to about 400 A. D.

Alcohol

NUMEROUS alcohols are known to the chemist, but that which he describes as ethyl alcohol is the one which is meant when we speak simply of "alcohol." Primarily it is obtained by distillation from a great variety of materials—wines, sugars, grain, and various other substances—each of which yields a spirit containing various ethers, essential oils, and other compounds which give it a characteristic odor and flavor. When intended for drinking purposes in the form of whisky, etc., the retention of some of these various ingredients is necessary, but by a special process of distillation it can be obtained free from them, in which case it is known as "patent" or "silent" spirit. Water is always present in this, and the strength of the silent spirit may vary greatly. One particular variety of still is reputed to produce silent spirit containing only 2 per cent of water, which is practically equivalent to what we call absolute alcohol, but usually there is much more water than this, and the spirit has to be "rectified" by redistilling. In the more ordinary process of production, the result of repeated distillation or rectification is a product containing about 90 per cent by volume of pure alcohol, and 10 per cent of water, which is known as rectified spirits, or spirits of wine. Continuing the same process will not reduce the quantity of water any further, and treatment with lime is necessary before a stronger spirit can be produced. By such treatment it is, however, possible to get rid of nearly all the water, and when not more than 2 per cent remains, the fluid is called absolute alcohol. The actual strength of this is usually about 99.5 per cent. This is, of course, the purest and strongest alcohol obtainable; but it is expensive, and stronger than is always required. If it is to be used mixed with water, we may just as well purchase a weaker and slightly cheaper variety, and the next definite strength is the so-called "rectified spirit," which contains 84 per cent by weight, or nearly 90 per cent by volume, of pure absolute alcohol. This rectified spirit is also known as "spirits of wine"; but the latter term being also used somewhat vaguely to cover alcohol in general, it is usually best to ask definitely for rectified spirits.

The next definite strength of alcohol is known as proof spirit, or as "spiritus tenuior" by the druggist. This is a standard strength adopted by the revenue authorities, and it contains 49 per cent by weight, or about 57 per cent by volume, of pure alcohol. Other strengths of alcohol are frequently described in terms of proof spirit, so that it is well to understand what it means. Rectified spirit is often described as 56 "over proof," which means that the addition of 56 parts by measure of water to 100 parts of rectified spirit will give proof spirit; it also means that we must take 156 parts of proof spirit to get as much alcohol as is contained in 100 parts of rectified spirit. Weaker spirits are styled "under proof," and 20 under proof means that 100 parts of the spirit contain only 80 parts of proof spirit. It is necessary to avoid confusing proof spirit with absolute alcohol, which is nearly double its strength.

A good deal of confusion has arisen over the matter of methylated spirit. Originally, methylated spirit consisted of a mixture of 90 per cent by weight of rectified spirit with 10 per cent of wood alcohol or wood naphtha. This compound was sold duty free, and could be used for most of the purposes for which pure alcohol was wanted, excepting, of course, that it could not be used in medicines, and it was assumed that no one would care to drink it as a beverage. This assumption proved, however, to be a mistake; it was drunk in large quantities, and so some years back petroleum was substituted for the wood spirit, the new compound being very unfortunately still called methylated spirit. This is allowed to be sold as freely as the old spirit; but restrictions have been placed upon the sale of the original real methylated spirit. The newer compound, miscalled methylated spirit, but more properly described as "denatured spirit," is useless for most of the purposes for which the older variety was employed. It is indeed of little use for anything except burning and the manufacture of varnishes. It cannot be used as a cheap substitute for pure spirit in chemical and photographic work, and therefore, if the cost of pure spirit is a consideration, the old methylated spirit, which is now known as "industrial spirit," must be procured.

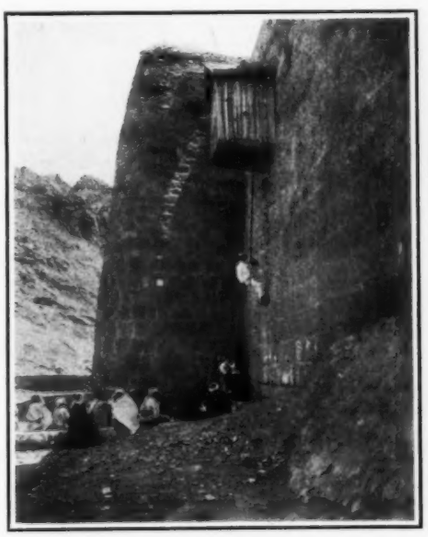
Unfortunately, there is yet another variety of so-called methylated spirit, which consists of the ordinary denatured spirit with one ounce of shellac dissolved in each gallon. This is technically called "methylated finish," but oilshops frequently supply it when methylated spirit is asked for. Indeed, in some cases it is the only kind kept in stock.

Alcohol is used for a variety of purposes in photography: for drying negatives, mixing carbon sensitizing-baths, making varnishes, and sometimes for dissolving developing agents. For all these purposes industrial alcohol can be used safely, though we prefer pure spirit for developers. In making up solutions with alcohol, there are one or two points that should be noticed. A mixture of alcohol and water is of less bulk than the sum of the volumes of the two ingredients, the shrinkage being greatest when 52.3 measures of alcohol are added to 47.7 of water. The total measure of the mixture is not 100, but only 96.36 measures, so that the diminution of volume is 3.64 per cent. The most important point to observe is that this shrinkage of volume is accompanied by a marked rise of temperature, so that if we add a developing agent dissolved in alcohol to water at normal temperature the mixture will for some few minutes be well above the normal temperature, and the resulting developer may be too warm. It should therefore always be cooled down before use.—British Journal of Photography.

French Butterfly Farms

THERE are in France butterfly farms, the object of the farmers being to rear rare genera of the Bombycidæ, the silkworm family. By crossing, some new varieties have been obtained, and these are much sought after by museums of natural history.

Endeavors are also being made in France to acclimate species of silkworms indigenous to other countries. The farms contain oaks, ailanthus trees, pines, plum trees, castor oil plants, and other plants the leaves of which serve as food for the caterpillars. Cocoons are hatched on branches protected by gauze, and, for the sake of uniform temperature, the insects are often kept in a room until after the first molting, when they are placed on bushes in the open air, and protected from birds by coverings of muslin or tulle.



ANCIENT WAY OF ENTERING THE MONASTERY OF ST. CATHERINE

PRIMITIVE ELEVATOR IN THE MONASTERY OF ST. CATHERINE. NO MORE IN ACTUAL USE

THE "HOLY MOUNTAIN"

The Knight Valveless Motor

A Highly Efficient Hydrocarbon Engine

THE earliest explosion motors, those of Lenoir and Otto, were constructed on the model of the steam engine, from which they borrowed the slide valve. Separate valves of the ordinary type were subsequently adopted, and for many years such valves were employed in all explosion motors, but a tendency to revert to the original solution of the problem has recently become manifest. In several motors of recent invention the valves are replaced by sliding devices, which, however, are not operated by the piston and bear no resemblance to the slide valve of a steam engine.

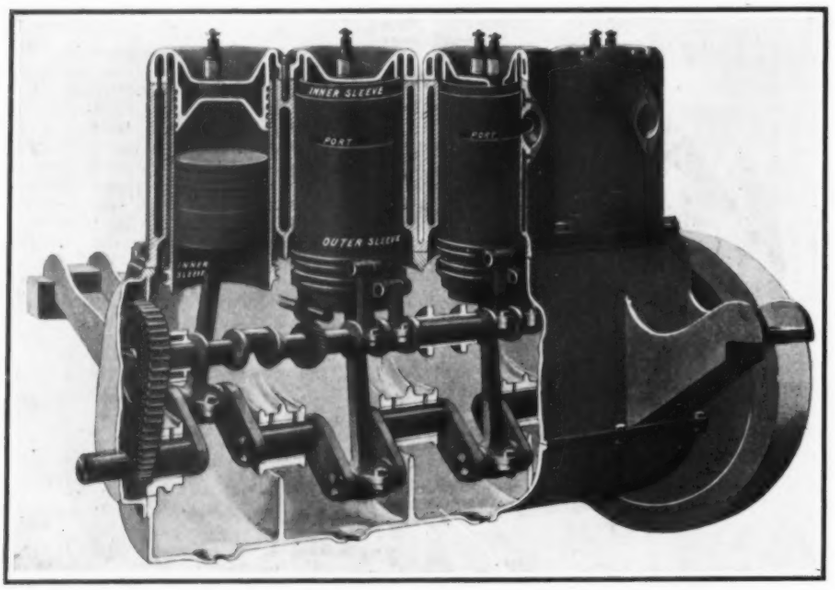


FIG. 1.—THE KNIGHT VALVELESS MOTOR

Separate valves have been tried and condemned. They are accused of causing many breakdowns, due to broken valve rods and adhesion of the valve to its seat. They also throttle the entering stream of gas and make too much noise. It is true that some motors provided with valves are almost silent and that most of the objectionable features of the valve are not inherent, but are due to faulty construction. At very high speeds, however, the valves fail to follow the contour of their operating cams accurately and run wild, causing a great loss of power, as shown by the indicator diagram.

Hence, valveless motors are coming into vogue. The new Knight, Hewit, Bingham, Mercedes and Rénaud motors are of this type. The Knight valveless motor, which appears to be nearly perfect in construction and operation, is now made and used by the celebrated automobile firms, Minerva in Belgium, Pankard-Levassor in France, Mercedes in Germany, and Daimler in England.

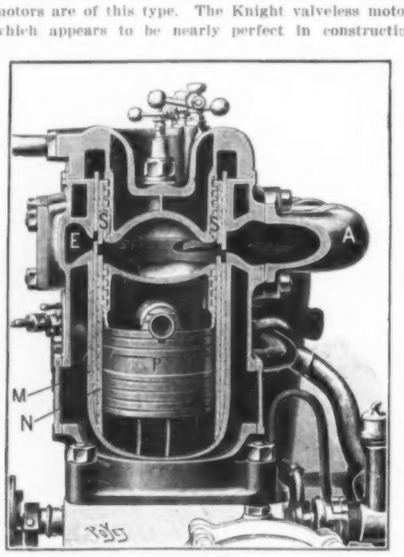


FIG. 2.—VERTICAL SECTION OF CYLINDER OF KNIGHT MOTOR

The Minerva-Knight valveless motor has four cylinders, connected in pairs. The top of each cylinder has two lateral orifices which communicate respectively with the supply pipe *A* and the exhaust pipe *E* (Fig. 2). The cylinder is surrounded with a water jacket and is lined by two thin, hollow cylinders, or sleeves, *M*, *N*, which have large lateral openings and which move in such a manner that they control the aspiration and exhaust of gas by bringing these openings opposite the smaller orifices of the large cylinder at the proper times. These sleeves are moved up and down by the rods *E* and *F*, connected with eccentrics on the shaft *A* (Fig. 3), which makes one revolution in each two revolutions of the main shaft *G*. In a motor of 35 horse-power the travel of the sleeves is one inch, while that of the piston is more than five inches. Hence the velocity of the sleeves is less than one-tenth that of the piston. The openings in the sleeves are so wide that the gases enter and leave the cylinder much more freely than they could do through valves.

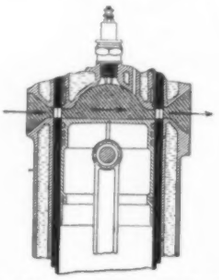


FIG. 4.—THE ARROWS SHOW THE SHORT AND STRAIGHT COURSE OF THE GASES IN A VALVELESS MOTOR

The motions of the sleeves and the positions and dimensions of their openings are so adjusted that each port is closed by one or both sleeves during three-fourths of the cycle and is kept open during the remaining fourth of the cycle by the simultaneous apposition of the openings in both sleeves upon the orifice in that side of the cylinder. During the first down stroke of the piston (aspiration) the inlet port is open and the exhaust port closed; during the first up stroke (compression) and the second down stroke (explosion) both ports are closed; during the second up stroke (exhaust) the exhaust port is open and the inlet port closed. At the end of the cycle, however, the exhaust port remains open for a very short time after the inlet port has opened, so that the products of combustion are completely expelled by the entering gas.

This motor is very silent, especially at high speeds, and is so flexible in operation that the speed of an automobile can be varied within very wide limits by simply controlling the admission, so that the differential need not be used, except for starting and backing. Another great advantage is presented by the constancy of compression, which is difficult to obtain with ordinary motors because of leakage at the valves, which also causes the carbureter to work badly and produces a loss of power. The absolute constancy of compression in the Knight motor is the cause of its perfectly uniform speed, for the intervals between

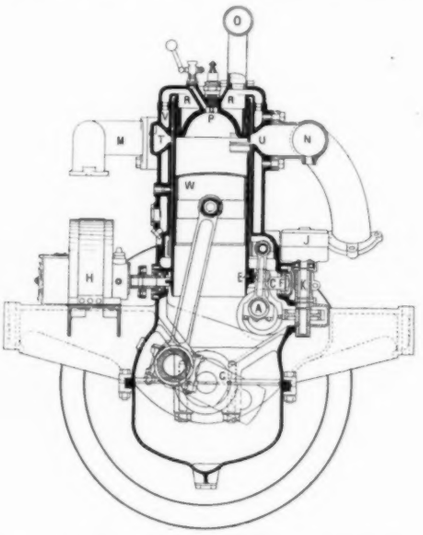


FIG. 3.—DIAGRAM OF CYLINDER OF KNIGHT MOTOR

successive explosions cannot be vigorously equal unless the compression is always exactly the same in all of the cylinders. In order to satisfy this condition there must be no leakage and the cylinders must be exactly equal in volume. It is impossible to obtain this perfect equality in castings, but the cylinders of the Knight motor are worked to the required dimensions and polished, so that they present no projections containing particles of carbon, which might become incandescent and cause premature explosions.

The moving sleeves are lubricated by oil which is drawn by capillary action between them and between the outer sleeve and the cylinder, and which fills horizontal grooves on the outside of each sleeve (Fig. 2). In these conditions the width of the interval between the surfaces is, within reasonable limits, of comparatively little importance. All escape of gas during the compression is prevented by a ring *S* (Fig. 2), which is pressed upon the inner sleeve by a spring, and by a thin layer of oil between the ring and the sleeve.

The vital parts of the Knight motor are the moving sleeves and the rods which connect them with the eccentrics. At 1,200 revolutions per minute, the normal speed of the 35 horse-power motor, the mean velocity of the sleeves is only 100 feet per minute.

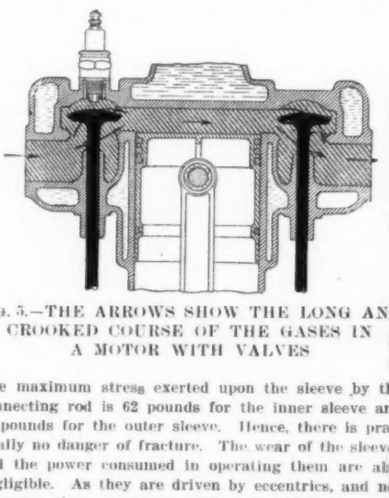


FIG. 5.—THE ARROWS SHOW THE LONG AND CROOKED COURSE OF THE GASES IN A MOTOR WITH VALVES

The maximum stress exerted upon the sleeve by the connecting rod is 62 pounds for the inner sleeve and 33 pounds for the outer sleeve. Hence, there is practically no danger of fracture. The wear of the sleeves and the power consumed in operating them are also negligible. As they are driven by eccentrics, and not by cams, they cannot go wild at the highest speeds. They open and close the ports exactly at the proper instants and their openings are so large that the power of the motor increases with its speed.

In a comparative test of two similar motors, one

with valves and the other without, the valveless motor developed 30 and the valved motor only 25 horse-power at 2,000 revolutions per minute. In another comparative test of two larger motors, the valveless motor developed nearly 45 and the valved motor barely 35 horse-power at 1,800 revolutions. In each case the introduction of the sleeves made the effective diameter of the valveless cylinders smaller than that of their competitors, the difference amounting to 1/4-inch in the smaller and 1/6-inch in the larger motors. The inventor claims that the power consumed by the motor itself has been measured by experiments in which the motor was driven, without gas, by an electric motor, and has been found to be only 13 per cent of the power developed by the motor, when operated normally at the same speed, so the efficiency of the Knight valveless motor is 87 per cent.

The form of the explosion chamber deserves special notice. Both the top of the cylinder and the top of the piston have a spherical curvature, and the concavities of the two face each other. By this construction the surface is reduced to a minimum with respect to the volume, and the exploding gases retain their heat and pressure longer than they would in a chamber having sharp angles between its bounding surfaces. The result is a smoothness and flexibility of operation comparable to those of a steam engine.

The Knight valveless motor has been subjected to many tests, which have yielded some surprising results. For example, a motor which produced 55 horse-power at 1,140 revolutions per minute, at the beginning of the experiment, developed 56 horse-power at 1,180 revolutions, after running one hour. A motor of 38 nominal horse-power, with cylinders measuring about five inches each way, developed 55.3 horse-power continuously during a run of 5 days and 14 hours at 1,200 revolutions per minute and consumed 0.85 pint of gasoline per horse-power hour. The motor was then placed on a car weighing about 2 tons, which made a tour of 2,154 miles at an average speed of 42.4 miles per hour. The motor was returned to the shop, where it developed an average power of 57.25 horse-power during a run of 5 hours at 1,200 revolutions, and consumed 0.75 pint of gasoline per horse-power hour. Hence, it had gained 2 horse-power by use.

The valveless motor, especially as it is represented by the type above described, marks great improvement, made at a time when the explosion motor was believed to have attained its maximum efficiency. It can be surpassed only by the turbine.

The Geological Society of America

Report of the Annual Meeting at Pittsburgh, Penn.

By E. O. Hovey

THE twenty-third annual meeting of the Geological Society of America was held in the Carnegie Museum, Pittsburgh, on December 27th-29th, 1910, under the presidency of Arnold Hague, LL.D., of the United States Geological Survey. About one hundred members were in attendance, and forty-five papers were on the programme, thirty-one of which were read in full or presented in abstract with the aid, usually, of lantern slide illustrations and numerous diagrams and maps. One of the principal papers of the meeting was the address of the president upon "The Origin of the Thermal Waters in the Yellowstone Park," in which Dr. Hague summed up the results of many years of study in the park, carried on mostly by himself and by parties working under his direction. He concludes that the waters of the geysers and springs are meteoric in origin, and that their elevated temperature is due to aqueous vapors rising from the deeply buried but still hot igneous rock of the region.

Of the papers presented by other members if the Society, by far the most important was that by Dr. E. O. Ulrich, of the United States Geological Survey, entitled "Revision of the Paleozoic Systems of North America." This revision takes into consideration all the work done upon these widespread fundamental formations for the past three-quarters of a century, and will form an octavo volume of about three hundred pages when published. It will doubtless arouse more discussion than any similar attempt at exact classification that has been undertaken.

Mr. N. H. Darton, of the United States Geological Survey, gave a brief summary of the results of studying the "List of Underground Temperatures in the United States" that he and several associates have been gathering together during the past fifteen years. A self-registering thermometer of special type has been used in making observations in about one thousand deep borings. The rate of increase of temperature has been found to be quite variable, but in places there is a marked relation to the geologic features of the region.

"An Unusual Distortion of the Lower Kittanning Coal" was the title of an interesting communication presented by Mr. Richard R. Hice, of the State Geological Survey of Pennsylvania. Of the whole Allegheny series in western Pennsylvania, no horizon is more regular and continuous than the Lower Kittanning coal; indeed, with its accompanying clay, it is one of the best keys of the series. While there are many changes and local variations in the sandstones and shales, caused in many cases by distinct erosion intervals, this coal, while not always workable, is uniformly found over a large area. It is not marked by distinct foldings or distortions, but by parallelism with both the under and overlying strata. At the site of Dam No. 5, on the Ohio River, on the eastern edge of the Beaver Quadrangle, between the towns of Rochester and Freedom, a recent railroad cut exposes, in a distance of some 600 feet, a series of foldings, involving the strata between the base of the Lower Kittanning clay and the horizon of the Middle (Upper) Kittanning coal (about 35 feet), in no way involving the underlying strata or those above the horizon of the Middle Kittanning coal.

The next paper was by Mr. W. T. Lee, of the United States Geological Survey, upon "Further Evidence of an Unconformity in the So-called Laramie of the Raton Coal Field, New Mexico." This important series of coal-bearing rocks is now shown to be divided into two parts, each of which carries coal, and the evidence is now pretty conclusive that there was a time break between the two formations. The lower is variable in thickness, and the observations indicate that the ancient surface represented by the unconformity was an undulating plain. Furthermore, the character of the conglomerate base of the upper basin shows that this plain was one of erosion.

Professor William H. Hobbs, of the University of Michigan, followed with a suggestive paper on "Repeating Patterns in the Relief and in the Structure of the Land." This paper was a discussion of patterns of relief, which in many districts repeat themselves like a diaper design in architectural ornamentation. Such patterns have their origin in a fracture system intersecting the outer shell of the lithosphere, and are best displayed in high latitudes, because there the vegetable cover is scanty, and frost action is the dominant weathering process. Where a country has further been partially submerged through depression, the expression of such patterns is strikingly brought out in landscape and map alike. Studies made in Norway during the past season have shown that the origin of such patterns in that district is in part explained by the spreading of joint walls at more or less regular intervals within each series and resulting heavy frostwork on these planes. A line of drainage once established, stream erosion, and in some cases mountain glaciation, have shaped the valley which is excavated. Patterns of relatively small size not only repeat, but, further, group themselves into diaper-like patterns of higher and higher orders. A compilation of data from widely separated districts in both North America and Europe reveals the existence of a primary pattern common to all areas, which is, however, locally obscured by the superimposition of additional disorderly fractures. Much light is thrown from these studies upon the nature of geological faults, which is also confirmed by later studies in seismology.

The upper surface of the great Triassic trap sheet in Montgomery County, Pennsylvania, sometimes shows a network of lines which closely resemble the sun cracks produced in a dry mud flat. These were described by Mr. Edgar T. Wherry, of Lehigh University, who stated that the lines were shown by a thin section to consist of coarsely crystallized augite and feldspar traversing a fine-grained ground mass, and he accounts for them by regarding them as shrinkage cracks developed by the sudden cooling of the molten trap against the contiguous shale, the cracks being then filled up by molten material from the interior of the igneous mass.

A note of the recent International Geological Congress which was held in Sweden was given in a paper by Professor James F. Kemp, of Columbia University, who described certain of the pre-Cambrian rocks of Sweden, and compared them with the corresponding rocks in North America. Much of Sweden is occupied by granites, gneisses, and schists, which bear interesting resemblances to similar rocks in Canada, New England, the Adirondacks, and other American regions. These Swedish beds are economically important for their content of iron ores and for their value in some places as sources of building and ornamental stones.

This paper was followed by one on "The pre-Cambrian of Southeastern Ontario," by Willet G. Miller and Cyril W. Knight, of the Canadian Geological Survey. This region is classic ground in American geology, and its rocks form an important part of the geological backbone of the continent, but they are extremely complicated in their relations one to another, and they still furnish field for active investigation.

A sketch of the local geology of the city of Pittsburgh was given by Dr. Percy E. Raymond, formerly of the Carnegie Museum, but now of the Canadian Geological Survey. Dr. Raymond said in part: "The city is situated along deep trenches, cut by the present rivers and in abandoned valleys of preglacial streams. Both were cut in a nearly level plateau, whose surface is from 500 to 600 feet above the present water level. Terraces and river gravels are well exhibited at many places along the abandoned valleys. The strata underlying the city are of middle and late Pennsylvania (coal measure) age, almost the whole of the Conemaugh and Monongahela series being well exposed. The nearly continuous exposures along the rivers afford an excellent opportunity for tracing the various beds, and many interesting changes in sedimentation, including erosional unconformities, may be seen."

Professor Gilbert van Ingen, of Princeton University, in a paper upon "The Shawangunk Grit and its Facial Relationships," brought out the shallow water origin and shore characteristics of this small but important formation stretching from Shawangunk Mountains southwestward into Pennsylvania.

Then Dr. Percy E. Raymond described briefly "The Chazy Formation in the Ottawa Valley," making some new subdivisions and correlations with the New York beds and showing the influence of ancient geological features as barriers to the movement of animal life.

Professor D. W. Ohern, of the University of Oklahoma, gave a paper upon "The Stratigraphy of the Lower Pennsylvania (coal measures) of Northeastern Oklahoma," in which he gave a brief summary of the subdivisions of some two thousand feet of rock strata covering an area of some 3,700 square miles. The beds consist of limestones rich in fossils, sandstones and shales poor in fossils, and some beds of coal.

A paper by Professor William J. Sinclair, of Princeton, N. J., and Mr. Walter Granger, of the American Museum of Natural History, described in some detail the "Eocene and Oligocene of the Wind River and Big Horn Basins," in which the authors stated in brief that comfortable superposition of Wind River beds on Wasatch and unconformable lower Oligocene on Uinta-Bridger-Lower Eocene have recently been found in the Big Horn and Wind River Basins, respectively, in northwestern Wyoming. These structural depressions, partly inclosed by the Big Horn, Bridger-Owl Creek, and Wind River Mountains, were receiving sediments during the Lower Eocene and Lower Oligocene, but since then have been subjected to deep dissection by streams and wind erosion, exposing sections of the teritiary filling. Nonvolcanic sediments predominate in these teritiary beds, derived in large part from the rocks of the surrounding mountains, shown by the abundant granite, gneiss and sandstone pebbles in the channel sandstones interstratified with the alternately banded red and blue or yellow clays of the Wasatch and Wind River, and by the presence of arkoses in the Uinta. Explosive volcanic eruptions are indicated by a few narrow tuff bands in the Eocene (Wind River), but especially by a great flow of andesitic agglomerate in the Lower Oligocene. Fine, wind-blown silts, highly calcareous marls, and siliceous spring deposits (chalcedony and opal) characterize the Oligocene above the horizon of the volcanic mud flow. Suggestions were offered in explanation of the alternation of color bands in the Eocene clays, based on lithologic and paleontological data. Early Teritiary orogenic movements, involving renewed uplift of the Big Horn arch, are demonstrated by a great marginal anticline found in the Wasatch and by the numerous sandstone dykes, apparently of seismic origin contemporaneous with the accumulation of the Wasatch clays.

A "Quantitative Classification of Meteorites" by Dr. Oliver C. Farrington, of the Field Museum of Natural History, is an attempt to arrange meteorites in accordance with the quantitative system of petrology as proposed by Messrs. Iddings, Cross, Pirsson, and Washington. One hundred and twenty-five meteorites have been assembled, all of which fall within two

classes of basic lavas as proposed by these authors, but the majority of the falls are outside of the groups in which terrestrial rocks actually occur.

Some important papers on economic geology were read. The first of these was by Professor J. A. Bownocker, of the State University of Ohio, upon "The Clinton Sand as a Source of Oil in Ohio." The author related the history of the exploitation of gas and oil in different parts of Ohio, with particular reference to the distribution of the Clinton sand and its position somewhat east of the center of the State where productive. The sand was originally correlated with the Clinton formation of New York, but it is now considered to be older. It outcrops in the extreme southwestern corner of the State, where it is barren, but it lies so low in the eastern part of the State that it has not been reached by the deepest borings. The wells from this sand have furnished first gas and then oil, the latter sometimes being of remarkable clearness and purity. Explorations are now in progress looking toward the extension of the oil-producing territory toward the north central part of the State.

This paper was followed by a valuable contribution entitled "Notes on the Geological Relations of Oil Pools Situated in Regions of Monoclinal Structure" by Dr. Frederick G. Clapp, of Pittsburgh, Pa. The author said in part: "Particular reference is made to the oil pools of southeastern Ohio, which may nearly all be classified as situated on monoclinal structures. Geologists and oil men have generally assumed that geological structure was of little assistance in predicting the positions of pools of this class. The main object of this paper is to show that geology is of great value in this, as in other classes of oil fields, and that good predictions may be made. The detailed structures of several well-known oil pools are given as examples. It has been discovered that in the great majority of cases the oil has accumulated at positions where the change in rate of dip is commonly proportional to the abnormality of the generally uniform dip. The positions of accumulation are also influenced by structural "ravines" crossing the sand. Although the structure of the sand may be quite different from that of the surface formations, it can, nevertheless, be calculated to a considerable degree of accuracy from the surface by taking into account the change in intervals, which is comparatively uniform for a given locality."

Metal mining was not entirely overlooked on the programme, and an interesting paper by Professor Frank R. Van Horn, of the Case School of Applied Sciences, Cleveland, Ohio, dealt with "The Occurence of Silver, Copper and Lead Ores at the Veta Rica Mine, Sierra Mojada, Coahuila, Mexico." The author said in abstract: "These ores occur on the contact or a short distance below the contact of an acid breccia with an underlying limestone of Cretaceous age. There are some indications of a fault plane between the two rocks, such as clay selvages and slickensides. There are two types of ore, a silver-lead and a silver-copper series. In the former group the minerals are all oxidized and consist chiefly of argentiferous cerussite, along with native sulphur and some gypsum. The bulk of the ores from this mine, however, seems to belong to the silver-copper group, and contains sulphides as well as oxidized minerals. Minerals noticed here were chalcopyrite, chalcocite, covellite, along with native copper, malachite, azurite, cuprite, and gypsum. Another zone consisted of a siliceous limestone containing up to 10 per cent of barite, which was impregnated with cerargyrite and native silver. Here the copper content was smaller, and rarely exceeded 2 per cent. Some three years ago a fault was discovered in the northern part of this 'silver-lime' ore body. Along this fault plane, silver and copper minerals of great richness were found mixed with more or less barite. Some of the minerals noticed were native silver, argentite, proustite, and pearceite, which has been found in but two or three localities in the world. At this point a mixture of erythrite and barite was also noticed, which seems to be the first observation of cobalt minerals in the district."

Turning to the glacial and physiographic section of geology, there were several papers of considerable local interest, and others of wider bearing. Among the latter may be mentioned one by Dr. William C. Alden, of the United States Geological Survey, upon "Radiation of Glacial Flow as a Factor in Drumlin Formation." There is a very notable development of drumlins in central eastern Wisconsin. These are grouped in three more or less distinct sets, corresponding to each of which there is a set of marginal moraines, which are believed to mark the limits of the glacial lobe during the stages when the drumlins were being formed. The outer moraine of each set marks the limit of the re-advance of the ice after an interval of recession. The drumlin belts and moraines show that the ice was radiating widely to the curved margin of the lobe, where it became thin in consequence of the radial spreading and of the loss by melting and ablation. Computations show that the spreading of the ice under its own weight alone would not account for its remarkable expansion. Hence, only the forward crowding of the more rapidly moving ice at the rear (north) could have supplied the requisite volume. Though the stream expanded greatly, so that friction was much increased, the remarkable development of drumlins indicates that the basal ice did not clog. Such basal movement was probably due to the ice being shoved bodily forward by the vigorously advancing ice in the rear, this forward shove being superimposed on such internal flowage as was taking place. It is believed that the application of such propulsive force in the region of the center of radiation of such as mass, which was tending to lag in every part owing to great friction, would tend to cause the longitudinal lines of flowage to spread and so develop stress along transverse lines. These stresses, though perhaps not causing the actual opening of longitudinal crevasses, would facilitate spreading of the ice about obstructing piles of drift and their being shaped into drumlins rather than their obliteration by erosion. It might also induce localized deposition in piles or ridges, which would later be shaped and might be added to by the plastering on of drift. Computations based on the ice stream forming the second set of drumlins show the radiation to have been even more marked than in the first case with corresponding greater crowding forward of the faster moving ice in the rear and more marked development of drumlins. Comparison with segments of the glacier which had equal initial widths but did not form drumlins, shows that in the latter there was very moderate radiation, and that unless the ice in the rear was moving more slowly than in front, there was a decrease in the volume of the stream as it advanced, as opposed to the increase in volume of the spreading of the ice under its own weight, and with no forward crowding of the ice in mass there would be absence of lateral stress and of the tendency to longitudinal crevassing, and this may explain the absence of drumlins. Other factors than radiation are probably also involved.

Prof. Lawrence Martin of the University of Wisconsin, in a paper on "Two Glaciers in Alaska," spoke in brief as follows: Among the glaciers studied by the National Geographic Society's Alaskan expedition of 1910 are two of unusual activity. Columbia glacier, in Prince William Sound, Alaska, began to advance in 1908, and has been visited on July 15th, 1908, June 24th and August 23d, 1909, June 30th, and September 5th, 1910, during which time its front has been progressing at an undetermined rate where tidal, but on an island and at the borders at the rate of from 0.9 to 2.1 feet a day, destroying forests and peat bogs and modifying marginal drainage and marine deposits. Childs glacier on Copper River was advancing at about its normal rate in August, 1909, the ice melting or discharging as icebergs into Copper River sufficiently fast so that the front remained nearly stationary. During the winter of 1909-1910 the rate of motion increased, a previously stagnant, shrub-covered part of the margin visibly advancing into the forest at the rate of 2 to 8 feet a day during June to October, 1910, when it was re-mapped at frequent intervals. Independently of this increased rate of advance, the position of the ice front in the river has oscillated during the summer with the stages of water in Copper River. A $1,400,000 steel bridge and the key to a railway system is threatened by this advance.

The social side of these gatherings is not its least important, and there were many conferences among the guests which were held more or less in private, the subjects of which were not entered upon the programme.

The Paleontological Society, a daughter of the Geological Society, held its meetings on the 28th and 29th of December. They were attended by audiences that were highly satisfactory in point of number and as to personnel. The papers delivered were decidedly technical in character, and they covered a wide range of topics under the general subject of paleontology. A second related society, the Association of American Geographers, began its sessions on the 29th and kept many men in Pittsburgh during the remainder of the week. The Association of State Geologists likewise held its annual meeting during the week.

Thursday evening, by invitation of the authorities of the Carnegie Institute, the members of all three societies participated in an informal smoker at the Hotel Schenley at the close of the delivery of the presidential address by Dr. Arnold Hague of the Geological Society.

Wednesday evening was devoted to the annual dinner of the Geological Society, which was presided over at first by Dr. Hague and was concluded under the leadership of Prof. James F. Kemp as toastmaster. The reports of the officers showed a good condition of the society, and there are many applicants for membership. The society lost seven members by death during the past year, and there are now 328 active members and 13 foreign correspondents. The election resulted in the choosing of Prof. William M. Davis of Harvard University as president, Prof. William N. Rice of Wesleyan University as vice-president, Dr. E. O. Hovey of the American Museum of Natural History as secretary, Prof. William Bullock Clark of Johns Hopkins University as treasurer, Mr. J. Stanley-Brown of New York city as editor, and Prof. H. P. Cushing of Western Reserve University as librarian for the year 1911.

The next meeting of the society is to be held at Washington, D. C., in connection with the annual convention of the American Association for the Advancement of Science.

The Light of the Sky

YNTEMA has made a series of investigations of the brightness of the sky, which may be summarized as follows: On some nights, when there is no visible moon or aurora, and the sun is more than 18 degrees below the horizon, the sky, whether clear or cloudy, is distinctly luminous, as a whole or in parts. The brightness of the sky, which usually increases toward the horizon, is sometimes equal to that of the diffused light of the half moon. Printed letters and the figures of a watch can be read with ease, and comparatively small objects at considerable distances can be seen—telegraph poles more than 300 feet away, for example. If the sky on these nights is clear, it appears white or pale blue, so that the Milky Way can scarcely be distinguished. On the other hand, there are clear nights when the sky appears almost black.

The brightness of the sky cannot be caused by the stars alone, for in this case it would be the same every night and would not increase toward the horizon, but would rather be diminished there by atmospheric absorption. The variation in the light of the sky suggests a terrestrial cause. Only a very small fraction of the luminosity can be explained by dispersion of light in the atmosphere, as is proved both by theory and by experiment. Yntema assumes that the earth is always surrounded by an aurora, which illuminates the entire sky to a greater or less degree. It is well known that the characteristic green line of the aurora often appears in the spectrum of the sky light, even when no aurora is visible to the naked eye.

Primitive Vaccination

THE November issue of Hygieia, the circular of the International Hygienic Exhibition which is to be held in Dresden next year, states that vaccination or inoculation, which is commonly regarded as a triumph of modern medical science, has long been practised by the civilized races of Asia, and even by African and other savages, probably as a result of Asiatic influence. We first meet inoculation for smallpox among the Chinese. Lockhart gives the following quotation from an old Chinese manuscript, which was probably written early in the 11th century: "The ancients possessed the knowledge of inoculation for smallpox. It has come down to us from the reign of Chin-tsung of the Ling dynasty, and was discovered by a philosopher. When the disease breaks out spontaneously it is very serious and often fatal, but when it is produced by inoculation it is usually mild and does not cause more than one death in ten thousand cases." In Persia inoculation is accomplished by scratching the forearm and rubbing into the slight wound after bleeding has ceased the pulverized scurf which falls from a smallpox patient. The Ashantee negroes, according to Bowditch, inoculate in seven places on the arms and legs. The Moors practise the same method. The Siamese have the peculiar custom of blowing the scurf into the nose. An interesting collections of material illustrating this subject will be shown at the Dresden exhibition.

An interesting sidelight on Chinese railways is contained in the report of Mr. Pitzipios, British consul at Chingkiang. A proposal was made to have a railway from Kuachou, at the mouth of the Grand Canal, to Hsü Chou Fu. Owing, however, to the indifference of the wealthy men of Yangchow and other places, the necessary capital could not be subscribed. One wealthy and influential Chinese gentleman of Chingkiang worked hard to secure funds, but met with rebuffs in all directions. Curiously enough, during the later months of 1909 a well-printed leaflet, bearing a rhyming song exhorting people to subscribe capital to build this railway, was freely distributed among the Chinese. The gist of it was to the effect that the trade of Chingkiang would suffer by the completion of the Tientsin-Pukow Railway, and that the Kua-Hsü Railway was the only thing to save the situation. All were, therefore, urged to buy shares at $5 each, payable at the rate of $1.25 a year. The exhortation included women and children, artisans, and coolies, and the present value of the Pekin-Hankow Railway shares was put forward as an incentive.

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Hub, resilient wheel, H. L. McDuffee 981,297
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Ice cream freezer, Butler & Abbott 981,060
Illuminating instrument, Martin & Golden 981,447
Incandescent bulbs, husk for, W. Lumley 981,207
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Incubator heater, E. Stahl 981,324
Indexes and the like, rod locking device for card, G. Mott 980,983
Ink fountain, C. H. Raymond 981,149
Inking machine, J. W. Reilly 981,085
Insecticide holder, L. S. Hill 981,264
Inside, shoe, D. Austin 981,154
Insulating cover for electric switches, M. Gnett 981,553
Insulating tubes, forming, W. R. Seigle 981,129
Insulator, split knob, H. H. Dupont 981,074
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Internal combustion engine, T. W. Heermans 980,946
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Iron ore, reducing, J. T. Jones 981,280
Ironing board, R. L. Cadr 981,283
Jar holder, O. F. Peterson 981,469
Knife holder and knife for cutting pile fabrics, A. Morton 980,992
Knitted fabric, producing openwork, R. W. Scott 981,318
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Lamp burner, J. Hodgson 980,952
Lamp cleaner, arc, L. Wipfeler 981,233
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Lamp holder, T. B. Monesmith 981,586
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Pipes, device for removing excrescences from, M. Berlin 980,914
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Saw handle, C. M. Minton 981,100
Saw table frame, G. L. Knights 981,451
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Shade or reflector, G. L. Krantz 981,576
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A printed copy of the specification and drawing of any patent in the foregoing list, or any patent in print issued since October 4th, 1850, will be furnished from this office for 10 cents, provided the name and number of the patent desired and the date be given. Address Munn & Co., Inc., 361 Broadway, New York.

Canadian patents may now be obtained by the inventors for any of the inventions named in the foregoing list. For terms and further particulars address Munn & Co., Inc., 361 Broadway, New York.

Aeronautical Notes

The Winner of the Paris-Brussels Race.—Herr Wynmalen, the Dutch aviator, captured the $20,000 prize for his flight from Paris to Brussels and back with a passenger in less than 36 hours on October 16th and 17th, 1910. Eleven attempts were made by leading aviators, but with the exception of Wynmalen none was successful. Legagneux, with Martinet as passenger, reached Brussels in record time on November 13th, but he was unable to return to Paris on account of the heavy wind. This was the second time he had made the flight one way.

Death of France's Oldest Lady Aeronaut.—Close upon the death of Octave Chanute in this country comes news of the death in France of her oldest woman aeronaut, Mme. Dozeville, who recently died at the age of 75 years, was a sister of Louis Godard, the well-known balloon and airship constructor. From 1855 to 1867 the then Eugenie Godard made numerous free ascents with her brothers Eugene, Louis, and Jules, and also a great number of parachute drops.

The Coupe Femina and Other French Prizes.—The last day of the old year aviatress Jane Herveu, the fifth French woman to receive an aeroplane pilot's license, attempted to beat Helene Dutrieu's record of 105 miles in 2:35, made on December 21st last for the Coupe Fémina. She only succeeded in flying 90 miles in 2 hours in her Blériot monoplane, however.—Lieut. Cammerman is the winner of the Weiler military prize of $5,000. He flew 232 kilometers (144.15 miles) with a passenger in 4:03:03 on December 21st.—Lieut. Caumont, while trying a Nieuport monoplane before competing for this prize, lost his life at Buc on December 30th.—The Duperdussin $5,000 cup for the quickest 100 kilometers (62.1 miles) flown with a passenger before the end of 1910, was won by Laurens on a R. E. P. monoplane on December 21st. His time was 1:16:05, which beats by 20 minutes Aubrun's record at Rheims and corresponds to an average speed of 48½ miles an hour.

The Baron De Forest Prize.—The prize of £4,000 given by Baron De Forest, mentioned below, was won by Thomas Sopwith by his flight on December 18th of 169 miles from the Isle of Sheppey, England, across the Channel to Beaumont, Belgium. Sopwith had a favorable wind. He crossed the Channel in record time and completed the flight in 3½ hours, averaging about 50 miles an hour. He used a Howard Wright biplane fitted with an eight-cylinder E. N. V. motor. Later, on December 22nd, Cecil Grace flew across the Channel and back again in his own Farman-type machine, but lost his bearings and turned out to sea when within five miles of the English shore. As his cap was picked up a fortnight later, he undoubtedly perished.

New Records for Michelin Trophy.—On December 30th last Maurice Tabuteau won the French Michelin Trophy for 1910 by a flight lasting 7:48:31 3/5, in which he covered 363.46 miles. Henry Farman attempted to beat this record the next day, but he was unsuccessful. He covered 302.6 miles in 7 hours 11 minutes' time. In England Capt. Cody covered 185½ miles in 4 hours, 47 minutes, thereby winning the English Michelin Trophy and special prize. In France four other attempts to win the Michelin Trophy were made upon December 31st. Marie covered 329 miles in an R. E. P. monoplane at Buc. Breguet and Sommer flew 242½ and 109 miles on their respective biplanes, while in the United States, near New Orleans, John B. Moisant, America's foremost aviator, was pitched from his machine and killed when about to compete for the Michelin Trophy.

Flight Across the Rio-de-la-Plata.—At Buenos Ayres on December 17th last, Cattaneo succeeded in flying across the Rio-de-la-Plata, a distance of 34 miles over the course followed. The Italian aviator was 2 hours and 35 minutes making the passage owing to an extremely heavy head wind. He eventually brought his Blériot safely to earth at Colonia and was awarded the $20,000 cash prize that had been put up for this flight—a flight much less difficult than that from Paris to Brussels and back with a passenger and for which a prize of the same amount (100,000 francs) was given. Baron De Forest, of England, also gave a prize of this amount for the English-built aeroplane, piloted by an Englishman, that should fly across the Channel and travel the longest distance into Belgium before the end of the year 1910.

The Wind and Aviation Above the Sahara.—It has been asserted that one of the chief obstacles to flying above the Sahara desert for utilitarian purposes such as the carrying of mail and the like was the violence of the wind. But on this point some very precise and almost conclusive information has recently been obtained by the National Aerial League of France. This information comes from Capt. Boué, chief of the geodetic brigade of the Tuniso-Tripolitan frontier. During last October Capt. Boué, with the aid of a Daloz anemometer which the league presented to him, observed the direction and velocity of the wind from Gabes to Djeneïen going via Kethana, Medonine, and Tataouine. During this month three entire days passed without any wind whatever, and never, except sometimes when there were gusts (only one of which showed a velocity of 20 meters per second—53¾ miles an hour—during two or three seconds) did the velocity of the wind exceed 12 meters per second (26¼ miles per hour). The daily average was but 4.4 meters per second (9.62 miles per hour). These observations are extremely encouraging since they show that, apart from the single day perhaps when the "sacred sirocco" was blowing, an aeroplane could easily have flown every day during at least eight hours out of twelve.

According to the Railway Gazette the Prussion State Railways Administration has been moved, apparently by a recent accident when signals were not observed, to issue new orders regarding the inspection of signals. Every year the officer in charge of trains, the officer in charge of signals, and an engineman selected for his experience and familiarity with the part of the line to be inspected, are to go over the road on a locomotive, but only two of them at a time on engines hauling trains. They are to pay particular attention to the following points: (A) The visibility of the signals—their background, their obscuration by telegraph poles, station buildings, trees, etc.; the effect on night signals of arc lights in the vicinity, or the reflection of other signals; the condition of the signal glasses. (B) The distance of the signal from the danger point. (C) The grouping of signals, where several stand near each other, in one row or otherwise; the appearance of the signal from every position in succession; the possibility of the confusion of signals. (D) The substitution for signals standing left of the main track of signals on the right of the track. (E) Substitution of high distant signals for low signals. (F) Superfluous signals. (G) The proper designation of main and branch tracks, where one post has several signals. If all these points be attended to, the signaling installation should be all right.

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